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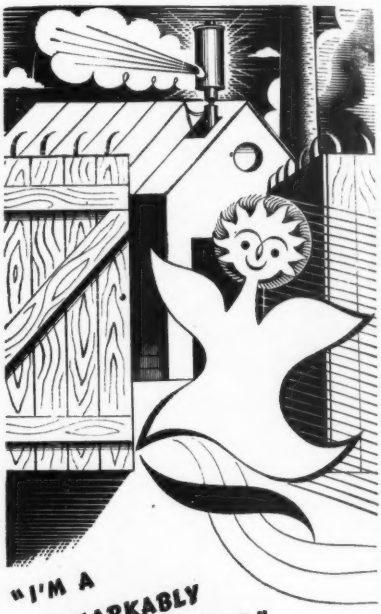

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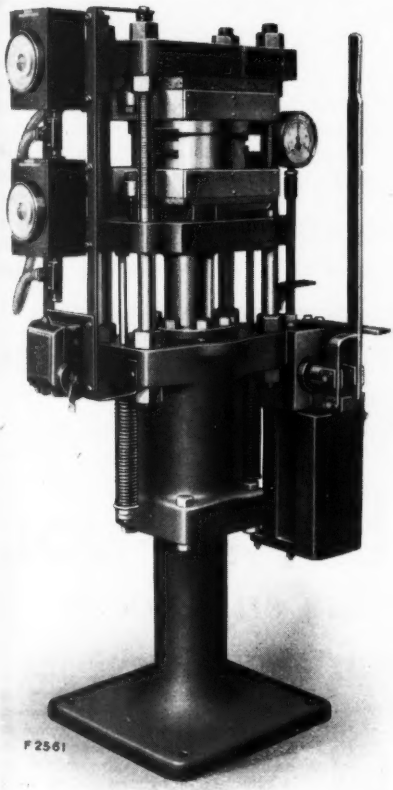

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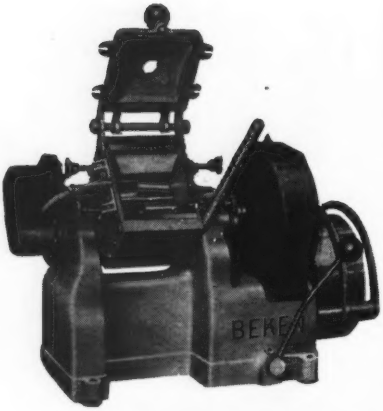

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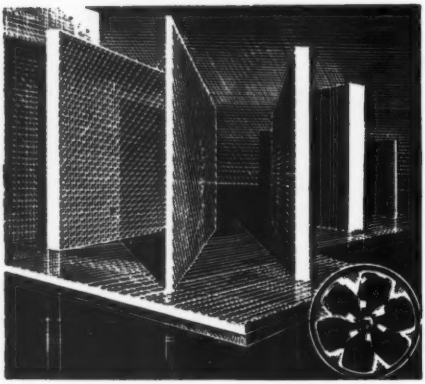

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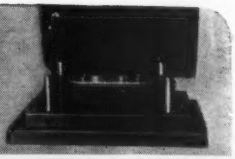

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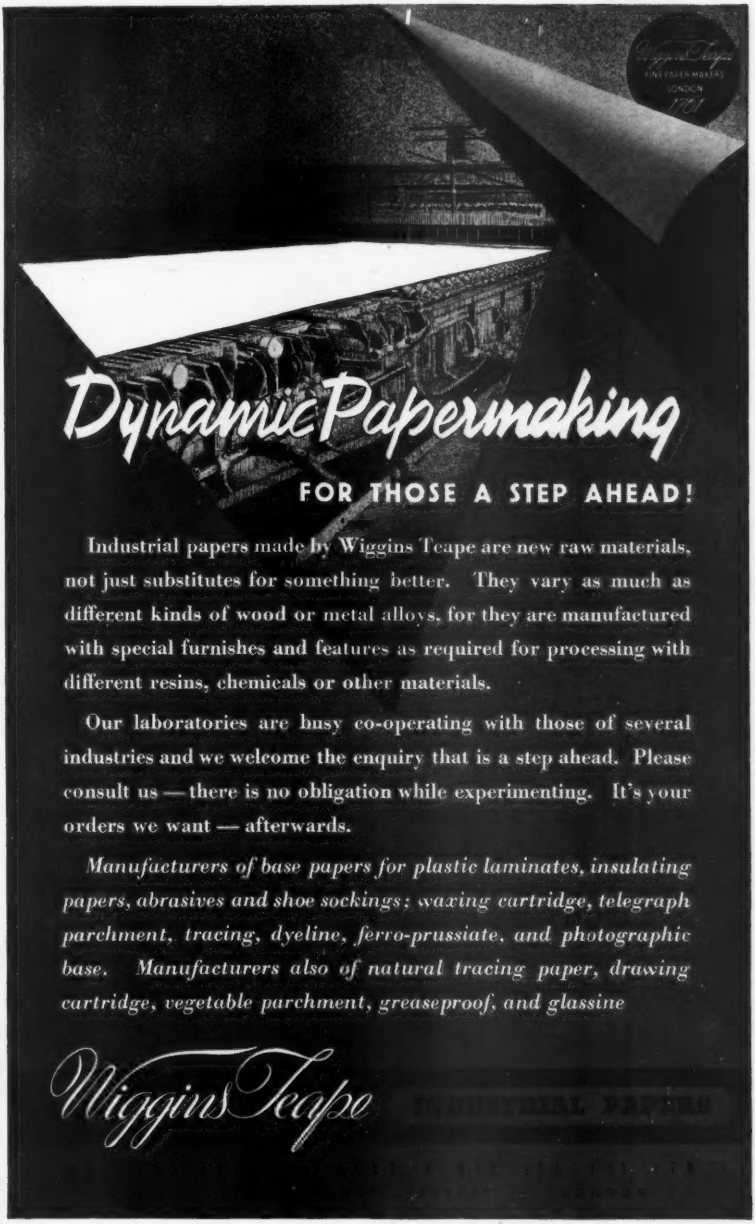
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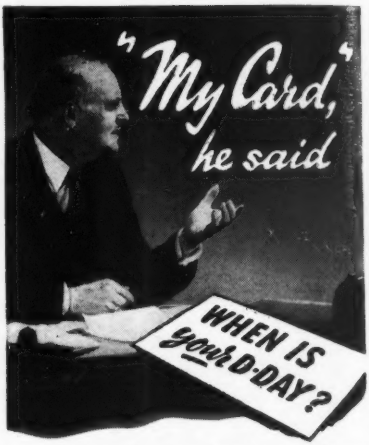

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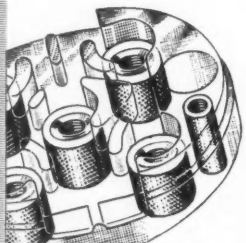

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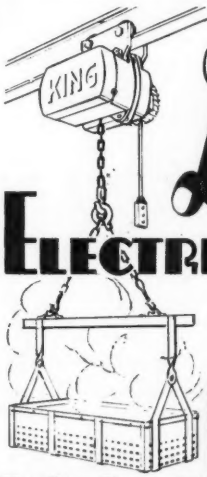

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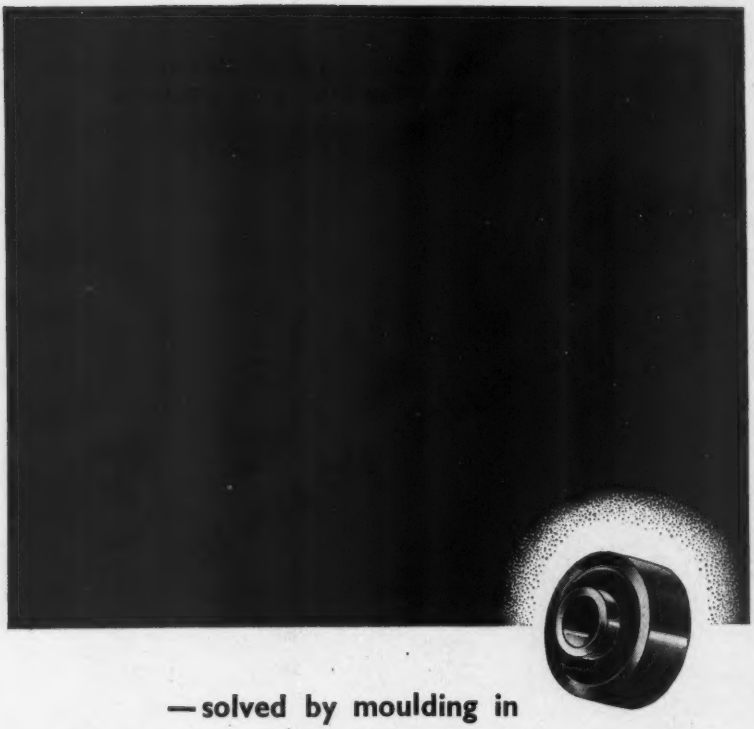

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Vol. X. No. 108 MAY, 1946

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.R.I.C.
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NOTICES

"PLASTICS" is published in London, England, about the middle of each month.
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All instructions, matter and passed proofs for all kinds of advertisements must reach the Head Office of "PLASTICS" by the first of the month to ensure insertion.

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EDITORIALS

Plastics in Scotland

WHILE southerners regard any northern outcry for Scottish self-government with some amusement and ruefully reply that England is already ruled mainly by Scotsmen, they will cock a more than friendly ear to any plea for the extension of Scottish industry, since a more intensive and scientific use of her natural resources, to say nothing of the undoubted energy and genius of her sons and daughters, cannot but improve the condition of the whole of the British Isles.

It seems strange that no chemical industry of great importance has grown up in the country. Just as the doctors turned out by world-famous Edinburgh seek their fortune (and find it) in the south, so can the engineers, chemists and physicists of Edinburgh and Glasgow be found in every country of the world.

The Scottish Council on Industry has for some time been considering the possibility of creating, among others, a Scottish plastics industry, and formed a Committee to inquire into the outlets for plastics in Scotland, the extent to which the industry is being developed and, finally, to suggest action to be taken as a result of the inquiry.

The Committee on Plastics has now made its first interim report, which makes very interesting reading. It is published from 51, Castle Street, Edinburgh, at the price of 1s. The following hard facts emerge from this report.

There is no manufacture of plastic materials (that is, moulding powders, etc.) in the country.

The number of moulders is not large, but includes several well-known names of companies, some of which went North during the war. The list now includes Kork-N-Seal, Ltd., who specialize in bottle closures, Hoover, Ltd., Ioco, Ltd., Aeroplastics, Ltd., Singer Manufacturing Co., Ltd., Technoplastics, Ltd., Aberdeen Combworks Co., Ltd., Scottish Moulding Co., Ltd., Thermotank, Ltd., Acme Wringers, Ltd., British National Electrics, Ltd., and Rowan and Boden, Ltd. (In passing, we were amused to note the inclusion of Rowan and Boden, Ltd., at the end of the list, unpremeditated, we are sure. To the knowledgeable, this concern and that of its "child," Roanoid, Ltd., has for many years signified all that is best and of the highest quality in the moulding of plastics. Neither appears to have suffered because of a tendency to self-effacement.)

As for manipulation and fabrication of plastics, this section is almost non-existent in Scotland.

One or two firms of toolmakers and engravers have undertaken the work of mould-making without serious difficulty, but some additional plant is required. Another section of the Report deals with the possibilities of further development. Extensions in moulding and fabrication in the manufacture of moulds and dies and of presses, machines and special equipment such as hydraulic plant, mixers, coating machines, impregnating and solvent recovery plant are obvious and quite within the powers of Scottish makers. What is not so obvious are the more basic manufactures of raw materials and plastic materials. According to the Committee, there would seem to be little immediate prospect of producing moulding powders, etc., but that it should be possible to encourage and develop the manufacture of raw materials, which could be supplied to plastic material manufacturers in the Midlands and elsewhere, until moulding and fabrication in Scotland had developed sufficiently to justify home production.

In the development of the raw materials for the industry there seems

great hope, for Scotland has coal, shale and cannel which could yield the phenols, ammonia and unsaturated gases involved in much plastics manufacture.

The action recommended by the Committee includes:—Encouragement to existing and new plastics concerns by financial support and the provision of factories; the promotion of conferences between the existing moulding industry and the engineering industry to discuss provisions of moulds; to ensure that the refining of petroleum should be extended in Scotland; to promote collaboration between the chemical interests, shale, coal and tar distillation, the plastics industry and the North of Scotland Hyro-Electric Board; to ascertain the amount of energy available in the new hydro-electric development for the manufacture of carbide and derivates therefrom; to promote research and trade classes.

We wish the movement every success.

Personal Note

WE had made a special visit to Scotland to obtain information of these activities in plastics, and immediately got into touch with our old friend Cecil Chapman, who, we note, is a very active member of the aforesaid Committee on Plastics of the Scottish Council on Industry.

Those Londoners who remember Mr. Chapman as the "life of the party" at many a meeting of the Institute of the Plastics Industry, will be glad to hear of his latest progress.

As a brilliant chemist and chemical engineer, he left Provan Chemical Works many years ago and joined the Monsanto Chemical Works, Ltd., where his interest in the raw materials of plastics manufacture began. He then became works manager of Cellomold, Ltd., at Feltham, and in the early years of the war transferred to Aeroplastics, Ltd., with works in Glasgow. Within the last few months he has started his own works under the title of Technoplastics, Ltd., at the trading estate at Hillington, Glasgow, and all readers will join us in wishing him the greatest of success.

In his well-laid-out shops we watched, among many well-conceived jobs, the making of a prototype plastic bottle. This was of cast polythene and should prove of great value. The cycling section of the community is extremely interested in it, as an unbreakable water bottle, and we suppose so should mothers who see a danger in the ordinary glass feeding bottle. Obviously, too, it is the ideal unbreakable chemical laboratory bottle.

Language Muddle

ALL of us have known for many years that some of the names and phrases we use in the plastics industry lack precision and are often mere jargon. The chemists among us know that when we say "phenolics" (which we use as a noun when etymologically it can only be an impossible plural of an adjective) we really mean "phenol-formaldehyde condensation product." But how can we, in the plastics industry, when writing or speaking to an audience often composed of technologists, business executives and even chemists, afford the time and space to do otherwise?

We have evolved a "shorthand" jargon, of little value, it is true, to the philologist, generally incomprehensible to the layman, and often ugly; but at least it is comprehensible, after search and contact, to the worker within the industry.

We have known our weakness in this respect and, in consequence, have gradually forgotten it. Those who wish to be reminded of it, and we ought to be reminded, should read an extremely valuable and learned paper recently published in the Proceedings of the British Society for International Bibliography. It is entitled "Plastics, Their Nomenclature and Classification," and is presented by R. J. W. Reynolds and W. A. Silvester.

This paper brings out the enormities of the language of plastics to the full. Our use of the very word "plastic" is erratic, and the definition of our "plastics" poor; we should not condone the expression "rose-coloured urea housing" since urea the chemical is so unlike the urea-

formaldehyde resin made from it. There are hundreds of such lapses.

The female section of the public use the word "nylon" to signify one thing only, namely, "sheer" stockings. To the boy in the street it is the tow-rope between the aircraft he saw passing overhead on that wonderful D-Day two years ago. To the plastics industry it is the raw material for producing a fibre, a moulding by compression or by injection or an extrusion, whether the finished article is a thick rod or tube or bristle. To the chemist it is a special polymer produced by an acid and an amine.

We talk of polyvinyl chloride and worse, p.v.c., while the public can only refer to "that new curtain stuff."

At least the British Society for International Bibliography can classify plastics from the chemical viewpoint by the Universal Decimal Classification. We wish it would help us in our own difficulties.

What Shall We Call It?

TRADE names add confusion to the muddle and unfortunately is beyond anybody's jurisdiction, but there is a great need to clarify our own minds and to systematize the products that pour from the factories, especially in regard to generic terms. And since our industry is so intimately tied to its customers, the industrialist and the public, such classification must be very carefully done with an eye to the propaganda value of names.

The game of nomenclature and classification is, in fact, always in progress in an indeterminate fashion, and indeed we have within the last month been asked to suggest a new name for a class of synthetic resins that are not used for moulding. We refer to those of the thermosetting type which are employed in the more or less pure form, that is without admixture of fillers, for so many purposes, such as the manufacture of laminated structures, adhesives, castings, impregnation of paper and textiles.

Thus far, we have divided "Plastics" into two very broad divisions "thermosetting plastics" and "thermoplastics" (we need not for the time being criticize these awkward descriptions).

The "thermosetting plastics" can be further divided from the technical point of view into two large groups: moulding powders and X, where X is the "pure" resin group described above.

As for the words "moulding powders," they are indeed poor things to use, and a new generic word should be found, and yet another coined for X. For the time being the latter is the more urgent.

Sheet or Foil?

SOME idea of the difficulty and the confusion in the nomenclature and specifications of plastics was shown at a recent meeting of the Institute of the Plastics Industry during the reading of an excellent paper entitled "Flexible Sheets, Films and Foils," by Reynolds and Midwinter.

The authors differentiated these forms by describing foils as being under 15/1,000 in. thick and sheets as being over 15/1,000 in. thick.

There is, of course, no "rules" and certainly no specifications yet for such materials, but we see immediately a great variance from metallurgical terminology, since 5/1,000 in. metal is "sheet."

Our main objection, however, is based on the reaction to the public. For example, no "mackintosh" of polyvinyl chloride is made thicker than 10/1000 in., and to inform the public that they are buying "foil" is to introduce an element of doubt as to strength, since it (the public) has always associated foils with thinness and weakness.

Loud Laughter

Curious juxtaposition of news items in a daily journal:—Estimated expenditure of the Department of Scientific and Industrial Research (this covers all Government-subsidized industries), for 1945-46, £1,817,217.

Estimated expenditure for Ensa (also Government subsidized), £5,000,000.

Plastics in the Chemical Laboratory

By C. H. BUTCHER

A WIDER field of utilization for plastics in making apparatus for chemical laboratory use appears probable as a result of the introduction of a new technique termed friction welding, which was discussed at a lecture given before the Institute of the Plastics Industry on March 27. At present, uses giving complete satisfaction are confined mainly to such items as weight boxes, scale plates, instrument bases, stands for thermostat baths, and certain odd parts of apparatus. Polymethyl methacrylate has found a useful application in the form of shatterproof goggles weighing less than two ounces, claiming to be free from distortion from the optical viewpoint and likewise as regards shape under stress of usage. Such goggles provide complete protection against injury to the eyes by the spattering of chemicals as well as from flying particles or other laboratory hazards. In a warm, humid atmosphere there is less tendency to "fog," compared with common glass and other transparent plastics.

The co-polymer of vinyl chloride and vinyl acetate has also entered laboratory use in form of flexible tubing for all purposes for which rubber has previously been employed. This material has excellent dimensional stability and tensile strength, and also many desirable characteristics such as non-flammability and a degree of abrasive resistance which is much greater than that of rubber. Its non-oxidizing property protects it from deterioration with ageing, which is a disadvantage of rubber. In form of tubing it offers good resistance to continuous flexing, but is not quite as elastic as rubber tubing. The notable resistance of the plastic to alkalis and even to oxidizing acids is a point of commendation for adoption, but caution has to be exercised in the presence of such compounds as aliphatic or aromatic ketones, acetic anhydride, etc., where some detrimental action occurs.

Labels for laboratory bottles are permanently protected by use of a plastics glaze which is highly acid and alkali resistant, almost invisible, and may be washed. All bottles in the laboratory show a tendency to soil in matter of the label; apart from any careless handling of the contents, there is laboratory atmosphere to be counteracted, irrespective of how well the removal of fumes is accomplished. This glaze is really a solution of polymerized resin in a quick-evaporating solvent. It gives a hard, transparent coating for labels, but has other uses in the laboratory, such as that of making apparatus gas-tight when applied to cork-and-glass connections, and in this application it is far more tenacious and easier to use than the paraffin wax once commonly employed.

The manufacture of measuring cylinders, burettes, beakers, flasks and funnels in plastic has been considered from time to time by the laboratory furnishers, but mould costs have been found prohibitively high in view of the comparatively limited demand for certain types of apparatus; in the case of burettes, which could not easily be moulded, any alternative method of fabrication has appeared to be high. Plastics are not universally applicable for every item where glass has hitherto been used, but nevertheless, the laboratory furnishers have shown a willing heart to experiment, and have gained some experience which it may be profitable to use. In most cases they complain that mould costs are exceptionally high, but, in the words of one, "From our point of view plastics are not all

that we expected of them, although some are usable and may offer outstanding use as experience is gathered." Another potential user, who has devoted much time to the investigation of possible uses in form of scientific apparatus, states that he has found thermo plastic resins to be objectionable in that they deform steadily under stress at quite low temperatures, such as 50 degrees C. As protective finishes these resins are very effective, but again, they cannot withstand any degree of heat, which makes them useless for general laboratory purposes. Thermosetting resins tend to be brittle, but are reasonably constant. The moulded thermosetting resins are normally far less accurate in their dimensions than is generally imagined, and where there is definite need for them to be used as component parts of apparatus, this inaccuracy is often enough to be serious. They also suffer from the great defect that some of the fillers are so " gritty " that, in absence of precise moulding with high cost for intricate moulds, parts cannot be machined to a desired shape with satisfaction. There has been marked improvement in usage by employing a very rough moulded homogeneous thermosetting resin which can be finally machined to size; but even then a period is required for "ageing," in order to allow the stresses in the material to disappear before it is put to use. Utilization in that manner, of course, denies one of the outstanding features of plastics generally, in that intricate shapes can be moulded with some defined precision.

Production by Friction Welding

The new technique of friction welding (which has already been referred to in " Plastics "), however, does certainly open up a new field of utilization for the manufacture of laboratory apparatus. The possible manufacture of beakers and funnels from polythene for acids generally, and polyvinyl chloride and polyvinylidene chloride made into condenser tubes for contact with nitric acid in particular, is attractive, if only for the elimination of breakage of laboratory glassware. The new friction welding promises such methods of fabrication as that of a measuring cylinder made by securely joining a wide diameter tube of transparent Perspex to a circular base of the same material, thus avoiding mould costs.

In this connection is it useful to recall that some guidance regarding attack of recognized plastics by acid and alkali was forthcoming from work done at the Plastics Industries Technical Institute, Los Angeles, duly reported to the American Society for Testing Materials, and published in their Bulletin, December, 1942. The acids selected for these tests were chemically pure nitric, sulphuric, and hydrochloric acids; caustic soda being representative of alkalis. Polystyrene and polyvinyl chloride-acetate, both $\frac{1}{16}$-in. thick, were practically unaffected by all concentrations of acid and alkali employed over the entire period of testing, which was 800 hours' duration. In this, these materials proved definitely superior to clear cellulose acetate, black cellulose nitrate, laminated phenolic paper-base plastic, and clear polymethyl methacrylate, all approximately the same thickness. While polystyrene appeared more resistant to strong concentrations of sulphuric acid, the copolymer of polyvinyl proved less affected by strong concentrations of nitric acid. Both products generally exhibited good resistance against attack by the acids used, in which they far surpassed the other products tested. Among the latter there were some which were entirely decomposed after contact with acid for several hours. In every case testing was conducted upon specimens which had been dried at 50 degrees C. for at least 48 hours prior to contact with the acid.

As regards those products which showed decomposition, it is interesting to note that the manner of this varied considerably. Cellulose acetate first whitened on the surface, and finally broke down to a shapeless mass. In other cases, notably laminated phenolic resins, there was a tendency for the laminations to separate in nitric acid, and for visible distortion

and decrease of dimensions in hydrochloric acid, whereas caustic soda produced visible swelling. The actual effect of chemical attack was measured in terms of reduction of physical strength (mainly punch and die test) made at regular intervals with immersion in the testing solutions. In general, the drier the sample the less readily was it attacked by either acid or alkali, as proved by test pieces which had been kept in an atmosphere of 30 and 75 per cent. humidity or otherwise allowed to remain in water for several days. This feature was very pronounced in the case of cellulose acetate tested in strong caustic soda solutions.

A certain range of concentration for caustic soda appeared to be particularly destructive towards plastic products generally. As far as tests revealed, this concentration was in the neighbourhood of a 5N solution, one containing about 200 grams per litre. As concentration rises above this strength there is less attack from the chemical viewpoint and likewise less deterioration of physical properties. As regards acids, the highest concentrations brought the greatest deterioration, but in the case of sulphuric acid there seemed to be a condition existing rather like that for caustic soda. Solutions of sulphuric acid (1N strength) exhibited greater attack than either 4N or 11N, but the maximum commercial concentration available (34.6N) had activity far in excess of all other strengths under observation. In the case of the phenolic plastics, it was not only the nature of the resin which determined the true resistance towards both acid and alkali: the reinforcement material also entered into this question, as shown by the fact that when a particular phenolic laminated product was attacked by nitric acid, the glass base was often impervious.

As regards the action of particular chemicals, polystyrene, polyvinyl chloride-acetate, and polymethyl methacrylate appeared to be unaffected by sulphuric acid (3 or 30 per cent.), nitric acid (10 per cent.), hydrochloric acid (10 per cent.), acetic acid (5 per cent.), caustic soda (10 per cent.), sodium carbonate (2 per cent.), sodium chloride (10 per cent.), ammonium hydroxide (10 per cent.), and hydrogen peroxide (3 per cent.); in the case of styrene there was a tendency to discolour. Ethyl alcohol (50 or 95 per cent.) had no effect upon styrene or vinyl chloride-acetate on immersion for seven days at 25 degrees C., but in the case of methyl methacrylate there was slight swelling with the weaker alcohol and surface attack at the higher concentration. Acetone exerted a solvent effect in all cases; toluene dissolved styrene and methyl methacrylate, but merely softened vinyl chloride-acetate; carbon tetrachloride had no action on vinyl chloride-acetate, showed surface attack in the case of methyl methacrylate, and dissolved styrene. These results of investigations are taken from a paper which was published by the American Society for Testing materials, June, 1941.

Considering the question of what properties would favour the selection of particular plastics for laboratory "glassware," foremost comes a general resistance against attacks by reagents commonly in use in the laboratory, with special attention given to common organic solvents. Secondly, there must be clarity and a colourless quality generally, to compete with laboratory glass; reasonably good machining, no distortion under influence of heat, neither any softening. Water absorption must be nil, either hot or cold; there should be no surface oxidation nor discoloration on exposure to sunlight or ultra-violet light (which is now finding so much laboratory use), and no embrittlement by age. The refractive index, thermal conductivity, and thermal expansion should not differ widely from that of laboratory glass, except in advantageous direction. The refractive index of a typical polystyrene is 1.67 and that of vinyl co-polymer is 1.53 (compare glass 1.51 to 1.61); coefficients of thermal expansion are 9.9 by 10^{-5} and 7.0 by 10^{-5} respectively (compare glass tubing, 8.3 by 10^{-6}, or glass flasks, 5.6 to 6.9 by 10^{-6}, being at least one-tenth of the figure for

(*Continued on p. 255.*)

Plastics in Germany

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office

CIOS XVI-4, 5, 8.—This report deals with the Belgian Plastics Industry as the result of a visit by Messrs. Philippe, Church and Ransom, to a number of Belgian factories. The main object of the visit was that it was understood that a M. Wengler was the Belgian representative of Venditor at Troisdorf, the large German firm of moulding powder manufacturers, and that an interview with him would be valuable. The notes enclosed in this report appear mainly to be information given by M. Wengler.

Venditor's capacity was stated to be a thousand tons of phenolic moulding powders per month, 500 tons of urea powders per month, 270 tons of polystyrene, and 30 tons of cellulose acetate. This firm also made Mipolam (p.v.c.); the quantity produced is unknown. Nowack A.G. has a capacity of 400 tons of phenolic moulding powders per month.

Verkaufsges. für Kunststoff was a central sales agency set up by the I.G.

H. Rommler A.G. at Spremberg purchased resins from Venditor and produced moulding powders at the rate of 200-300 tons per month for use in their own moulding shop. Bakelite G.m.b.H. was totally destroyed early in 1943. Four hundred tons of phenolic formaldehyde per month were made by this concern. F. Raschig G.m.b.H., of Ludwigshafen, produced 200-300 tons of phenolic moulding powders per month. It is believed to have been bombed.

Report 2.—Compagnie Generale Belge D'Isolants et Des Produits Moulus. This company was stated to have produced plastic articles for the German Government. This firm possesses about 50 moulding presses, injection moulding machines and laminated board and tube making equipment. They are the biggest trade moulders in Belgium, possessing their own toolshop and impregnating and tube-winding equipment. The firm stated that it engaged in a form of passive resistance throughout the occupation, as a result of which they only devoted 10 per cent. of their moulding output to German stores. They also deliberately produced mouldings that would be rejected upon inspection. A representative of the firm stated that he knew of no new special developments in thermosetting materials and that the quality of German phenol and cresol moulding materials fell off about the middle of 1942. About the same time cotton fillers were replaced by paper and the resin content of the powders was reduced, in some cases to about 30 per cent. He also stated that so far as he knew the largest injection yet made in Germany had a capacity of 300 grams and this was considered a giant.

CIOS XXXI-77.—This is an interesting description of the fabrication of plastic containers used for the storage of hydrogen peroxide on German submarines. The bags holding concentrated hydrogen peroxide, 83 per cent. in water, were fabricated by G. Hagen A.G., of Cologne, from polyvinyl chloride. Composition of the p.v.c. sheet was 10 parts "Igelit" powder, 6 parts "Palatinol" plasticizer and 3 parts "Mesamoll" plasticizer. Details of the fabrication of the containers includes the interesting note that welding is carried out by a jet of hot air (200 degrees C.).

BIOS REPORT NO. 282. Items Nos. 22, 31.—This report is a description of the German Casein Industry as it affects 13 well-known producing companies. It is interesting to note that owing to the

(Continued on p. 241)

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THE SHAPES REPRESENT A CASTLE, CAR AND BOAT WHICH ARE USED FOR THE MODELLING OF SAND. MOULDED FROM SHOCK-PROOF PHENOLIC, UREA-FORMALDEHYDE OR CELLULOSE ACETATE MOULDING POWDERS.

ORIGINAL DRAWINGS FROM THE OFFICES

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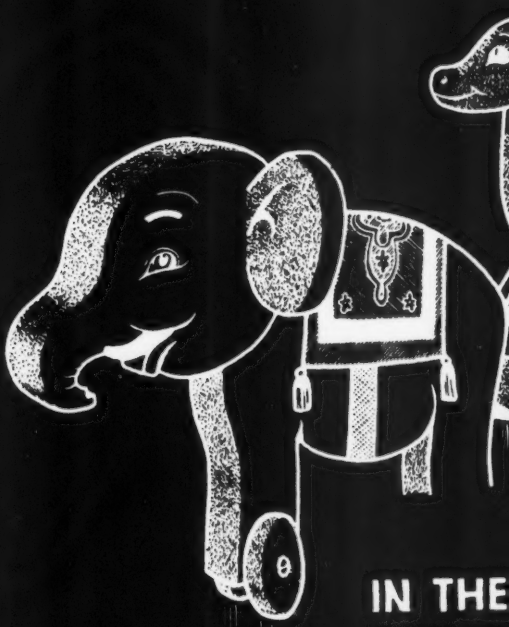

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WINGS FROM THE OFFICES OF GEORGE B E SCHUELER PLASTICS CONSULTANT

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MELAMINE TREATED PAPER BEARING THE DESIGN

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PLASTIC TOYS
AT THE SEASIDE

The Microscopic Examination of Plastic Materials

VI.—Mouldings: (a) Fillers (Wood Flour)—contd.

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

UP to the present we have dealt with the structure of wood relative to its eventual use as flour as a filling material for thermosetting moulding powders. We have seen that wood in general is built up of a mass of tubular elements which possess mechanical strength by virtue of the cellulosic walls becoming thickened in various ways by the process of lignification.

After the completion of lignification, the living ground tissue dies and the protein and starchy matter is absorbed, thus leaving a lignified skeletal tissue which is formed at the centre and gradually spreads outwards as the stem grows. This woody tissue functions merely as a supporting member and when in this condition is known as mature wood, whereas, while it is still living and transporting fluids, it is known as green or sap wood and, as such, is undesirable for use as a filling medium, by virtue of the presence of quantities of proteins and starchy substances.

We have also seen that of the two classes of wood, i.e., Coniferous and Deciduous, the former possess only one type of xylem element of a thickening so characteristic as to constitute a valuable aid to identification; this thickening was also shown to lead to a relatively small degree of lignification, in consequence of which it was concluded that the mechanical strength of the tissue elements followed suit. This conclusion appeared to be somewhat anomalous when the strength of the wood itself was examined; but on considering the structure as a whole it was seen that the xylem elements were found to lie in both vertical and horizontal planes, as a result of which the mass of elements was closely interlocked and bound together.

Thus it would seem that, even with a relatively weak element, the way in which they are orientated in the final structure has an appreciable influence on the mechanical strength of the latter. This is interesting because we may use it as an analogy in comparing it with the structure of a moulding. We have seen how the xylem elements are cemented together during their development, with lignified material, if we now consider this to be analogous to the resin, then the tissue elements may be regarded as the filler, in which case it will be seen that the orientation of the particles of filler will play an important part in the production of mechanical strength in the finished moulding. Likewise, it will also appear that the particles of filler should be of a filamentous nature, that is to say, the length of the particle should be many times its diameter. This assumption would seem to be justified because in practice we know that a cotton flock filler, which consists of a relatively long cotton fibre, produces stronger mouldings than wood flour. In all probability this is due to the cotton fibres interlocking with one another.

This improvement is particularly noticeable with respect to impact strength. Thus Fleck* quotes an impact strength of 0.2 ft.-lb. for a normal wood-flour filler and 0.35 ft.-lb. for a cotton-linters filler. The greater degree of orientation of the filler elements in the case of the cotton is

* Fleck. "Plastics Scientific and Technological." Temple Press Ltd.

presumably the reason for the increase in strength, which conjecture, as we shall see later, is supported right through the range of different types of filling materials until we come again to the laminates, where the orientation is directly controlled, as a result of which we obtain the highest strengths.

From the foregoing remarks, it may be concluded that, whatever the filler used, it is preferable to have it in a form where the elements are of a fibrous nature, with

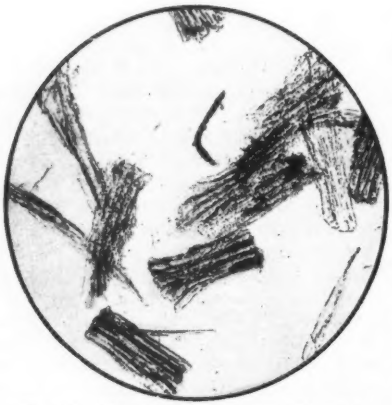


Fig. 81.—Wood flour, softwood, 56 mesh. Mag. 52 diameters.

the fibre length of the largest possible size compatible with good moulding properties. Thus, in the case of cotton flock, the fibre is of considerable length in comparison with its diameter, and a moulding powder which utilized this entire length would produce very good results, but, unfortunately, this feature cannot be utilized as in the breaking down of the mixture to a powder the maximum length of fibre available becomes limited to that of the largest grain of powder in any given sample. Thus we see that the size of the filler element requires to be examined in close relationship with the particle size of the moulding powder, and as moulding conditions dictate the grain size, inasmuch as they are influenced by the viscosity of the moulding powder and the design of the mould, etc., it will be seen that the selection of a filler for any particular duty involves a number of factors which have a general effect as well as affecting one another. This point will be discussed in greater detail subsequently.

Returning to the specific case of wood flour, we have seen that the softwoods possess the lowest strengths and that the hard or deciduous woods appear to show promise of producing better fillers by virtue of their greater fibre strength, but the virtue of wood lies in its fibrous nature, be it soft or hard, and, therefore, the primary consideration in producing a wood flour lies in the manner of disintegration. In the case of the softwoods we have only one type of xylem element, namely, the pitted tracheid which is approximately 1/32 in. long. The process of disintegration should produce a flour consisting of these elements in their entirety, that is to say, the flour would be made up of individual tracheids only. Theoretically, this process is relatively simple, as it only involves masceration in suitable oxidizing solutions, but there are at the present time inherent difficulties which prevent its use on an industrial scale, nevertheless it should not be overlooked as it is highly probable that, given the incentive, it may be workable on a commercial basis.

The process in common use to-day employs attrition grinding by some means or other, with the object of endeavouring to defibrate the wood rather than cut it up into small pieces as would be experienced by grinding by impact. This method does achieve some measure of success inasmuch as it produces powder elements of reasonably uniform length, but it does not seem to be an efficient method of separating the individual tracheids; rather does the powder consist of small bundles of these latter instead of single tracheids.

This is well illustrated in Fig. 81, which is a photomicrograph of a softwood wood flour of 56 mesh. As will be seen, the elements of the flour consist of bundles of tracheids still cemented together, although it should be noticed that the

general size of the elements is remarkably even, which brings to light an interesting point inasmuch as the length of these powder elements varies from 0.0118 in. to 0.0192 in., that is, from just over 1/100 in. to a little under 1/50 in., which would appear to indicate good control over the sieving of this material.

The main point, however, is in the nature of these bundles, for it will be seen that as there are a number of portions of tracheids to each bundle, the extent of orientation experienced under any given set of conditions would not be so great as would be the case if the flour consisted of separate whole tracheids, because in the latter case, if one particle is not orientated, the effect of this would be negligible when compared to the effect of one bundle not being orientated. This condition results in the same effect as would be produced by the same number of tracheids as contained in the bundle being thus displaced.

Another important point requiring consideration is the effect of wood flour on the moulding characteristics of the powder. It is well known that wood flour aids the flow properties and mitigates the effects of shrinkage by helping to distribute the stresses more evenly throughout the moulding. It is obvious that this would be best achieved if the flour consisted of single tracheids, as then they would still retain their fibrous character and yet be more effective in bringing about easier flow and less shrinkage, owing to the ease with which more even distribution could be obtained. In this way, it is probable that greater strength and stability would be obtained, together with better moulding characteristics.

At the present time, however, it would appear that the same effect is sought after by using a wood flour of smaller mesh, so suppose we examine some materials of decreasing mesh sizes, and see what conclusions we can arrive at. Fig. 82 shows a softwood flour of 80 mesh photographed at 52 diameters. The first thing which becomes apparent is the great differences in particle size, for we see large, thick bundles of tracheids, as shown at A, whose length varies greatly, together with portions of bundles as at B, and we see here also some particles consisting of only one or two tracheids, as shown at C. These are probably the most useful elements in this flour, as they closely approach the long, narrow fibre which is so desirable, but, on the other hand, we have, forming a background to the other elements, a quantity of very fine particles, probably consisting of cellulose or lignin, which are most unwelcome, as they are the antithesis of our concept of long, narrow fibres, and it is difficult to see what function they can perform apart from acting as an extender to the resin; apart

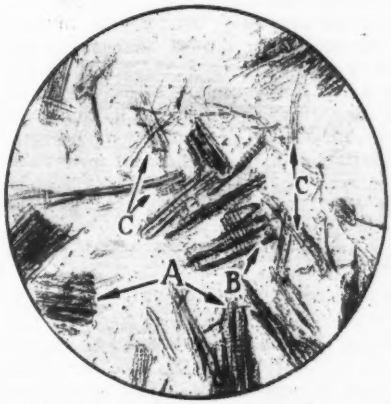


Fig. 82.—Wood flour, softwood, 80 mesh. Mag. 52 diameters.

from the doubtful possibility that they may help in reducing shrinkage, one would be justified in regarding these fine particles as an adulterant.

On the whole, the decrease in mesh size from 56 to 80 seems to have produced some fundamental changes, resulting in a mixture of powder elements not encountered in the coarser flour. It should not be assumed, however, that the 56 mesh flour is entirely free from other types of elements, such as minute flakes of cellulose or lignin, but in general it may be taken to contain a very much smaller percentage of these latter than the 80 mesh. To offset this, we have in the

80 mesh flour a reasonably high percentage of the long fibrous elements, which would appear to be more useful than the type of element encountered in the 56 mesh flour. Thus, in certain circumstances, it is highly probable that the 80 mesh flour would be capable of producing a stronger moulding than the 56 mesh, in spite of the presence of these minute flakes.

The difference in mesh size from 56 to 80 is quite considerable, but it serves to illustrate the changes encountered by finer grinding. This is still further illustrated by the changes observable when we proceed from 80 mesh flour to 100 mesh, such as illustrated at the same magnification in Fig. 83. We see the bundles encountered in the 80 mesh flour, but their average length is shorter. We also see that the percentage of elements consisting of single, or at the most two or three, tracheids appears to be somewhat greater; at the same time an increase in the percentage of minute flakes or "dust" is also larger. Thus, in this case, we would be tempted to conclude that the strength-giving properties of the wood flour would be slightly less than those of the 80 mesh, by virtue of the preponderance of short bundles of tracheids and "dust" over the fibrous elements, especially so, as it would seem that even these latter elements are beginning to suffer in the process, inasmuch as some of them have been unduly shortened, as shown at A (Fig. 83). As a result, their efficacy as strengthening elements must be seriously impaired.

In order to follow up these changes, suppose we examine next a wood flour of 120 mesh, such as that illustrated in Fig. 84 at 52 diameters. The same type of wood is used, viz., Swedish softwood, and at this mesh we have a greater relative change for a similar increase in mesh number than that seen between the 80 and 100 mesh flours. We find that the bundles of tracheids are almost entirely non-existent, but instead the majority of the flour is made up of the shortened single tracheid elements and dust. Some few longer elements of this nature (A)

Fig. 83.—Wood flour, softwood, 100 mesh. Mag. 52 diameters.

do exist, but they are so few and far between that their effect would be too small to be noticeable. Thus we may regard this flour as being composed of two elements only, the shortened single tracheids and "dust," and as such one would be justified in saying that as a strengthening medium the flour would not be of much use; in fact, it would act mainly as an adulterant. It does, however, bring to light an interesting point, inasmuch as we appear to have reached

Fig. 84.—Wood flour, softwood, 120 mesh. Mag. 52 diameters.

and passed an optimum value for mesh number, because we have seen that whereas the 56 mesh material would not be expected to be very effective when incorporated in a moulding powder, as the bundles would tend to produce uneven distribution of the strength. The 80 mesh material was better, as it showed signs of the presence of a fibrous element of considerable length, but the 100 mesh flour indicated a downward trend in the strength-imparting properties, as the fibrous elements were seen to be suffering by being shortened, and at the same time the dust was present in larger proportion. This trend, we can now see, is continued in the 120 mesh flour.

We obtain some further evidence of this if we go to extreme lengths, such as, for example, a wood flour of 200 mesh, illustrated in Fig. 85 (here again the magnification is the same), from which we see that the fibrous elements, that is to say, single tracheids, are so much shortened as to appear almost as fine as the dust seen in the previous examples, in which condition, of course, they are most ineffective as a means of imparting strength to a moulding, for the tracheids only exist as small portions thereof, and as such have almost completely lost their identity. Likewise the dust exists in a much greater proportion, and the material as a whole approaches in structure that of a fine mineral powder.

Thus we are faced with the interesting conclusion that the mesh or element size of wood flour used as a filling medium for moulding powders possesses an optimum value at which it has a maximum capacity for imparting mechanical strength to a finished moulding. This would appear to be due to the method of manufacture of the flour, which shows a tendency to produce individual tracheid fibres of maximum length and quantity in a mesh number lying between 80 and 100.

This conclusion is given some measure of support by some interesting figures produced by Rupprecht and quoted by Smith*; these are shown relative to impact and bending strength in Table V.

Table V.

Average grain size	Approximate mesh No.	Impact bending strength	Bending strength
mm.		CmKg/sq.cm.	Kg./sq. cm.
2	12 to 15	6.8	770
0.25	100	9.3	923
0.125	180–200	6.8	793

From the foregoing figures it will be seen that the optimum value is reached at about 100 mesh, when the fibrous flour elements are in the most effective proportion relative to those of the dust and bundle elements.

It will be apparent that if the method of breaking down the wood were to consist of a true "defibration" producing 100 per cent. fibrous elements in the form of single tracheids, then the mesh number of such a flour would be smaller, that is to say, the grain size would be larger.

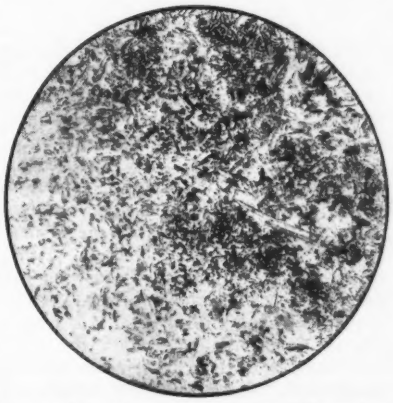


Fig. 85.—Wood flour, softwood, 200 mesh. Mag. 52 diameters.

There are objections raised to the use of a coarse wood flour on the grounds that it affects surface finish and causes difficulties in moulding, particularly where thin sections are required. The surface finish problem is debatable inasmuch as many mouldings are produced with very coarse fillers, such as tyre cord,

* Paul I. Smith. "Plastics for Production," p. 106. Chapman and Hall.

where the surface finish is quite as good as that on many wood-filled products. Similarly, it is difficult to see how a coarse grade of wood flour would produce any great difficulty in moulding, provided that the flour elements were fibrous in nature. Suppose we consider the 56 mesh flour first examined; this was seen to consist of bundles of tracheids and may be considered to be a coarse flour. The difficulties encountered by its use would give rise presumably in its restricting the flow of the mixture into fine apertures in the mould, due to the wood flour particles being subjected to a filtering action and piling up at the entrance to the aperture. How fine this aperture would have to be to produce this condition, with the mesh of flour under discussion, would have to be determined by careful experimental methods, but it is reasonable to suppose that an aperture of 1/25 in., which is twice the mesh size, would not cause undue inconvenience in moulding. This would represent a cross-sectional thickness of 1/25 in. in the moulding at this point, and it is difficult to visualize any moulding wherein the designer has so ignored the requirements of mechanical strength as to call for a section of this thickness. Thus it would seem that the coarseness of the wood flour used for filling is not so important from this aspect, always bearing in mind that the term coarseness is relative. For example, one speaks of "fine" sawdust, which, in terms of wood flour, is extremely coarse and would conceivably give rise to the aforementioned difficulties.

The mesh size of wood flour is, on the other hand, very important, because, assuming we get true defibration in the process of manufacture, then the coarser the flour we can use the stronger will be the finished product, as the fibrous elements will be longer and consequently more effective. This increase in strength with a fibrous filler appears to be due in part to the intertwining and interlocking of the fibres during the flow period of the moulding operation. This point will be discussed in greater detail when we come to deal with fibrous fillers.

Having dealt briefly with the question of the effect of mesh size on mechanical strength, and having seen that there exists what appears to be an optimum value for this, one would be led to assume that a similar condition appertains in the case of the percentage of filler incorporated in the moulding powder. That this is so is shown by Halls,* who gives a curve indicating compressive strength against percentage wood flour. Thus Table VI shows the figures (taken from the curve) for this variation.

From these figures it will be seen that the compressive strength reaches a maximum with a 25 per cent. wood flour content. These figures are presumably for 80 mesh flour, as Halls quotes that figure as being the most popular, which is also

Table VI.

% Wood flour	Compressive strength p.s.i.
5	26,250
10	28,000
15	28,700
20	28,900
25	29,000
30	28,700
35	28,200
40	27,300
45	25,800
50	23,750

(as we have seen) about the optimum value, but, on the other hand, it must be borne in mind that the results observed so far concern only the one type of wood, viz., the softwoods, and it is quite conceivable that in the case of the more highly lignified woods, where the fibre length is as a rule considerably greater than that encountered in the conifers, the same figures will not be true, and, furthermore, these optimum values will, in all probability, vary with the species. So that it will be seen that if the hardwoods are to be used as filling media, then much work remains to be done with regard to establishing these optimum figures.

Apart from the critical values relating to the resultant strength, we must not overlook any that may exist with regard

* E. E. Halls. "Fillers for Plastics," September, 1942, 307.

to moisture content. This is obviously of prime importance when considering the resultant electrical characteristics. As the presence of water in the finished moulding is most undesirable, it is necessary to keep this as low as possible, therefore it would seem that the woodflour should be incorporated into the resin while quite dry. Halls (Loc cit) is of the opinion that this may be best achieved by baking the flour in an oven in order to remove all traces of moisture, and then mixing it while hot.

There are one or two objections to this method of ensuring low moisture content, the first of which would appear to be the undesirability of adding any further heat to the already heated resin, which would quite conceivably make the condensation of this latter beyond controllable limits.

The major objection, however, would appear to be the effect on the mechanical strength, for we have seen that the wood fibre develops its maximum strength at a moisture content of 4-5 per cent. (see April issue). Thus it will be appreciated that by completely drying the woodflour we are actually weakening the fibres, upon which depends the mechanical strength of the finished moulding,

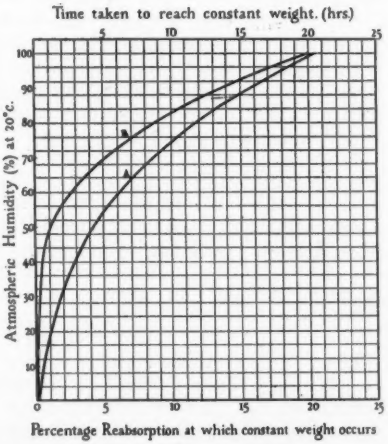


Fig. 86.—Relationship between percentage absorption and percentage humidity.

although it should be remembered that as the major reaction product resulting from the curing process is water, this will be re-absorbed to a large extent by the dry wood flour and some of its strength will be regained, but whether the water so absorbed would constitute 4 per cent. to 5 per cent. of the weight of wood present is a problematical point.

Thus, if we are to produce the strongest moulding mechanically, we must of necessity sacrifice some of the electrical properties, and here again we strike an optimum figure of 4-5 per cent. moisture content in the wood flour. This content requires carefully regulating, as will be seen from a study of the re-absorption characteristics of dry wood flour. These figures, given by Halls (Loc cit), are shown in Table VII, from which it will be seen that, with an atmospheric humidity of 50 per cent., the re-absorption of moisture reaches a constant value of 4.0 per cent. in one hour, and, at 75 per cent. humidity, the re-absorption becomes constant at 9.9 per cent. in 7 hrs. and so on.

Table VII.

Time of reabsorption (hrs.)	Percentage water re-absorbed for atmospheric humidities at 20°C.		
	50%	75%	100%
½	2.9	4.9	8.4
½	3.9	6.7	10.6
1	4.0	8.5	12.2
2	(Constant weight)	9.0	14.5
4		9.6	16.1
7		9.9	17.5
20		(Constant weight)	20.6
24			(Constant weight)

We see, therefore, that as the atmospheric humidity increases, so it takes longer for stability to become established, and also the point at which stability is reached is represented by an increasingly high constant water content.

From these figures we may derive two interesting curves. Fig. 86 shows the curves for the relationship between the percentage re-absorption at which constant weight occurs and the percentage humidity (Curve A), on the one hand.

(Continued on p. 276)

FLEXIBLE FUEL CELLS

A British Achievement of Outstanding Merit, Born of War-time Research

THE idea of constructing a tank with fuel-retaining cells of flexible non-metallic material is as old as the 1914-1918 war, but it was not until 1939 and 1940 that the early self-sealing tanks were fitted into fighter and bomber aircraft. It was not until 1945 that what might be called the apotheosis of this type of fuel storage was produced by the combined research work of I.C.I., Ltd., and Marston Excelsior, Ltd.

The " Marflex " fuel cells, as they are called, have four outstanding advantages over other types of tanks for aircraft:—

1. Maximum capacity for available space in the aircraft structure.
2. Low weight/capacity ratio.
3. Ease of installation in inaccessible places.
4. High protection against fire in crash or heavy landings.

This British development began like all similar work with the drive for the production of bullet-proof metal fuel tanks. The research quickly developed, however, into the production of the flexible type by experiments with Neoprene (synthetic " rubber ")-coated fabrics. The Leathercloth Division of I.C.I. made the aforesaid fabric, while Marston Excelsior produced the tanks by a special method of tailoring the Neoprene-coated fabric on wooden jigs.

In 1941 the big demands for Neoprene for so many other war purposes, and also the fact that Neoprene has certain disadvantages for tanks of large capacity, made it necessary to seek an alternative.

Experiments with Formvar, the well-known synthetic resin produced by the Shawinigan Company of Canada, used with a multi-ply fabric, gave very good results in the conditions then existing, and the material was put into production.

Towards the end of the war very high-altitude flying and tropical service raised problems of conditions of extreme temperatures, which Formvar, plasticized with diacetin, could not withstand with complete satisfaction. Once again I.C.I. research provided the answer with a fabric proofed with a derivative of Formvar, namely, Formvar-glyceryl-adipate. This synthetic resin, calendered on to two-ply cotton fabric, is stable and flexible over a very wide temperature range indeed. It is, of course, quite impermeable to petrol or aviation spirit. The tank material itself consists of a

sandwich formed from the fabric with an intermass of the resin.

Marston Excelsior, the fabricators of the tanks from the I.C.I. material, have excelled in the method of "tailoring" on to wood formers; these are of wood, interlocked and held by screws, and can be completely dismantled after the tank has been built around it and withdrawn through a hole in the tank wall.

In addition to aircraft fuel tanks, the "Marflex" principle has been applied to self-sealing tanks for amphibious and armoured vehicles, large-capacity tanks for motor torpedo boats, 2,500-gallon storage tanks for carrying aviation fuels on rail trucks, and experimental tanks of many different types to meet special naval requirements. Last, but not least, ground storage tanks of 800- and 2,500-gallon capacities have been supplied in large quantities both to the Ministry of Aircraft Production and the War Office. The storage tanks can be rolled up and easily transported from point to point, and quickly erected again when needed to hold stocks of petrol against future requirements.

The cell-walls of the various types of these non-metallic tanks vary in weight and thickness, according to their purpose. For passenger and freight aircraft there are light-weight cells with walls .05 in. thick and 4 oz./sq. ft. in weight. Cells for this purpose provided with a crash-protecting layer are $\frac{1}{8}$ in. thick and 13.1 oz./sq. ft. in weight. Cells for naval craft and land vehicles provided with full protection against 20 mm. shells are $\frac{3}{4}$ in. thick and $2\frac{1}{2}$ lb./sq. ft. in weight.

PLASTICS IN GERMANY

(Continued from p. 232.)

shortage of Rennet Casein the manufacture of casein plastics in Germany ceased in 1941 excepting only the Galalith Co., which continued to manufacture on a reduced scale until 1944. Most of the machinery has been idle for four years, with resulting considerable deterioration.

The following points are considered of some interest to the British Casein Plastics Industry.

(1) The methods used by Oechsler and Sohn, Ansbach, of producing button blanks.

(2) The machinery for grinding of shaped rods for the pen and pencil trade.

(3) The methods used to produce fancy patterns.

(4) Chemicals for the production of transparent effects.

(5) Details of extruding machines held to be the best by all casein plastic manufacturers.

About five of the thirteen concerns have been partly or completely destroyed.

BIOS REPORT NO. 92. Item No. 22.—This report describes the production of acrylonitrile at the Leverkusen plant of the I.G. Farbenindustrie for use in the manufacture of acrylic resins. The report is a chemical engineering one and is accompanied by photographs and drawings.

FIAT REPORT NO. 62.—This report describes the work of the I.G. on polyamides. Most of the polyamides, known generally as Igamides, have been developed for fibre manufacture and were used during the war for the production of tyre yarn, parachute yarn, parachute cord, and bristles. A maximum production was 330 tons per month. With special Igamides a lot of preliminary work has been done on the injection moulding of combs, brushes, shoe trees, hardware for furniture and so on. It is also stated that billiards balls and bowling balls and pins were also manufactured; the loading of the former was carried out with barium sulphate to give a specific gravity equivalent to ivory.

G

World's Industry Employs Plastics

GENERAL ENGINEERING

Machinery construction is taking increasing advantage of the possibilities of plastics, according to an account in "Engineering Materials," 1945/**4**/331. Long experience is ample confirmation that gears of modern laminated materials provide silent action, whilst a new development is foreshadowed in the possibility of Nylon for bearings. **Shot for blasting purposes** in the form of Tenite pellets is being manufactured by the Tennessee Eastman Corp. Their special virtue, it is said, lies in the fact that they are able to clean the surface of soft metal without any abrasive action, in the ordinary sense of the word. It would seem that their use is especially to be recommended for the metals where surface perfection is highly important if maximum fatigue properties are to be maintained, e.g., magnesium-base alloys ("Scientific American," 1946/**174**/176). **Melamine formaldehyde plastics,** thermoplastics, and "post-formed" laminates are discussed in two accounts in "Engineering Materials," 1946/**4**/311. **Low-pressure type laminating resin** developed by the Plastics Division of I.C.I. makes possible the production of large tough laminates of complicated design with simple equipment. A wide range of applications is thus opened up for these materials, not only in the electrical, furniture and allied trades, but also in shipbuilding, the motor and aircraft industries. Contact pressure resins are especially suitable for the construction of shaped laminated articles, using fabric or paper. The resin in question, a brown viscous fluid, is applied by brushing or bath impregnation. It has a resin content of 40-50 per cent., depending on the use projected for it, and is cured for half an hour at 100 degrees centigrade ("Chemical Age," 1946/**54**/364). **Bending strength of plastics** by means of a new apparatus developed by O. W. Ward and A. Bailey is described in A.S.T.M. "Bulletin," 1946, January, p. 33. The authors claim that accurate reproduceable results are obtained by their method on specimens weighing as little as one gramme. Work on **Silicones** referred to in the yearly report of the B.T.H. Research Laboratory was devoted *inter alia*, to the use of these materials as applied finishes capable of standing continuous heating to 200-250 degrees centigrade. Technical difficulties in producing silicone rubbers have, it is said, been largely overcome, and at present attention is being concentrated on oils and greases. Silicone oils exhibit a negligible change in viscosity with temperature, and, apart from their uses as lubricants, are attracting considerable interest as hydraulic fluids ("Mechanical World," 1946/**119**/188). Under the name "Asidbar," the Koppers Co., Pittsburgh, is stated to have developed a plastic which is notably acid resistant, and can be machined as readily as wood (Polyt. Tydscrift, 1946/**1**/13A, March 23). **Glass-reinforced plastics** are discussed in an account in "Materials and Methods," 1946/**23**/720. In the same journal, on page 762, is reproduced an engineering data sheet dealing with the storage and preparation of phenolic materials prior to moulding. **New plastic reinforcement** for special grades of glass fibre has been developed by the Owens-Corning Fiberglas Corp. Forming of laminated phenolics is described in an

account in "Machinery" (London), 1946/**68**/53. **Handles for saws and screwdrivers in ethyl cellulose** permit a wide range of those decorative qualities valued in tool components of this nature. The use of the material for hammer handles, however, is of more than general interest as for this purpose the mechanical properties demanded are of a highly specialized nature.

ELECTRICAL

Highly viscous plastics which can be moulded to form with the application of very little heat have, it is said, been developed by the B. F. Goodrich Chemical Co. Amongst the applications cited, are storage components, insulators of all types, together with components for optical instruments such as lenses and prisms ("Scientific American," 1946/**174**/176). **New luminous plastic** has been developed by Monsanto Chemical Co., it is stated in "Engineering Materials," 1946/**4**/340. It possesses an afterglow potency more than double that of any phosphorescent thermoplastic produced prior to 1939. **Decrease in electrical resistance** of methyl methacrylate, glass-bonded mica, glass phenolic laminate, fabric phenolic laminate, fibre-filled phenolics and wood flour-filled phenolics, after prolonged exposure of the materials to fungoid attack and atmosphere of 97 per cent. relative humidity at 25 degrees Centigrade, has been investigated by J. Leutritz and D. B. Herrmann. The report is presented in "A.S.T.M. Bulletin," 1946, January, 6. 25. **Gauze of highly reflective properties,** and marketed under the trade name "Glame," is referred to in "Textile World," 1946, January (abstracted McGraw-Hill "Overseas Digest," 1946, February, p. 7). It is a fabric-like structure manufactured from regenerated cellulose and weighs only 4 ozs. per sq. yd. It has a characteristically high reflective power for colour. In "Modern Plastics," 1946/**23**/121, reference is made to the unusual role of moulded Durez in combination screw drivers and wrenches designed for adjustment, etc., in wireless apparatus. Here the tool holder is made of metal, the **wrench and blade section of the driver being in plastic.** The object is presumably to avoid damage to screw heads or to the facets of nuts and bolt heads.

AIRCRAFT

Requirements for laminated plastic domes and windows in pressurized-cabin aircraft are best met by methacrylate sheet laminated with a polyvinyl butyral core. Solid acrylic sheet, it would seem, has not proved entirely satisfactory. ("Aviation," 1946, January, cited in McGraw-Hill "Overseas Digest," 1946, February, p. 14.) Under the name of "Plastipeel," "Plastiform," "Plastipaste" and "Plastitool," have been developed four new plastics intended specifically for use by aircraft manufacturers, but obviously capable of much more extensive employment. The Duorite Plastics Industries are the manufacturers. ("Materials and Methods," 1946/**23**/790.)

MOTORS

Automobile body produced entirely in plastic is notable for the use of glass fibre reinforcement. It will not dent under a blow which would severely damage bodywork of normal steel construction. The Owens-Corning Glass Corp. is responsible for the development of the material. ("Engineering Materials," 1946/**4**/343.)

MISCELLANEOUS

The silicone resins, it is pointed out by G. H. McIntyre, are, in spite of their being considerably more heat resistant than present-day resins of normal constitution, not at all likely in the form of applied finishes to compete with vitreous enamels, although to some extent they do help to bridge the gap between these latter and the normal stoving finishes. ("Products Finishing," 1945/**10**/80.) **Plastic cements in scientific instruments** is ably dealt with by J. C. Swallow in "Journal Scientific Instruments," 1946/**23**/44. The use of these materials in the construction of instruments for optical, electrical and chemical purposes is discussed at length. Further developments in progress will depend to an increasing extent on growing appreciation and knowledge of the physical and chemical properties of plastics and particularly of the techniques for handling them. **Increase of 161 per cent. in the activities of the American Plastics Industry** is predicted for 1946 by the American Committee for Economic Development. ("Scientific American," 1946/**174**/107.) One authority, indeed, appears to consider that the industry may already be on the way to surpassing this figure and cites the growing use of plastics in the motor and allied industries. **Special lamp unit** designed to emit germicidal rays is mentioned in "Scientific American," 1946/**174**/170. **Pot scourers of Plaskon resin** manufactured by Downy Products Co. are referred to in "Popular Science," 1946/**148**/136. Referred to in the same journal are straps made of polythene for wrist watches, these being manufactured by the Pla-Safe Plastics Corp. Advertisement devices and premium tokens produced in plastic materials are referred to in an account in "Scientific American," 1946/**174**/158. **The nomenclature of plastics** and their classification has been made by R. J. W. Reynolds and W. A. Silvester, in a paper read before the British Society for International Bibliography. (Proc. Brit. Soc. Int. Bibliog., 1945/**7**/72.) Particular attention is directed to the discussion following this paper. Various suggestions made in textbooks and official classifications have been carefully compared. The authors remark that the versatility of plastics precludes a strictly logical presentation. **Shoes were manufactured in Russia during the war from polyvinyl chloride,** it is reported in "Polyt. Tydscrift," 1946/**1**/13A (March 1). In the same journal, on page 13B, a reference is made to "Cafelite," produced, as noted before in this journal, from surplus coffee in Brazil. Material is valuable for the production of furniture and domestic ware. **German plastics industry** between the years 1939-1945 is described in "Products Engineering," 1946/**17**/218. The account is based on the reports of official investigators. The industry appears to have been particularly efficient in the development and application of unsaturated polymers. The production and application of various other plastic materials are mentioned, in particular the polyamides and unplasticized polyvinyl chloride (Luvitherm). **Processes for joining plastic or foil** for heat-sealed packaging is announced by Sav-Way Industries, Detroit. ("Machinist," 1946/**90**/58.) **Nylon and latex in fashion creations** are discussed in "Science Illustrated," 1946/**1**/32. The account refers to the use of melamine in pullovers and to stockings, etc., treated with Syton resin. **New suction pump for acids** manufactured by Alden Speare's Sons Co., U.S.A., takes advantage of the ability of numerous plastics to withstand the corrosive action of chemical media of this type. ("Scientific American," 1946/**174**/160.) **Plastic letters and masks** for artists, manufactured of thin flexible Lumarith sheet and coated on one side with a special pressure-sensitive adhesive, the whole being laminated to thin opaque paper, are offered by Arthur Brown and Bros. (U.S.A.), "Scientific American," 1946/**174**/160.

The clean lines of the design give an air of brightness and spaciousness to the bar of this plastics buffet car.

THE FIRST ALL-PLASTICS RAILWAY BUFFET CAR

WHAT is probably the first all-plastics buffet car in the world has just been added to the Southern Railway's London-Dover boat train. The car was formerly a Pullman coach, but has been gutted and entirely redesigned, utilising Warerite laminated plastics. Walls, bar, partitions and table tops are all faced with this plastics material in a colour scheme of pink, grey and cream, while plastics are also employed for the display cases, lighting fittings and curtains.

The design of the car was undertaken by Mr. Richard Levin, a member of the Industrial Design Unit of Bakelite, Limited. The object of this Design Unit is to improve designs for plastics and to ensure that plastics are properly employed. The general effect in this coach indicates that all these objects have been successfully achieved. Quite apart from the air of freshness and warmth which the interior treatment affords, the employment of plastics for this purpose has, of course, many practical advantages. They are hygienic and extremely light in weight—less than half that of aluminium. They will withstand knocks and hard wear and effects of travellers' careless treatment in the spilling of hot liquids, fruit juices and alcohol do not cause permanent blemish. In addition, the materials adopted in this instance will not support combustion.

Without straining at the potentialities of plastics, the design has exploited them

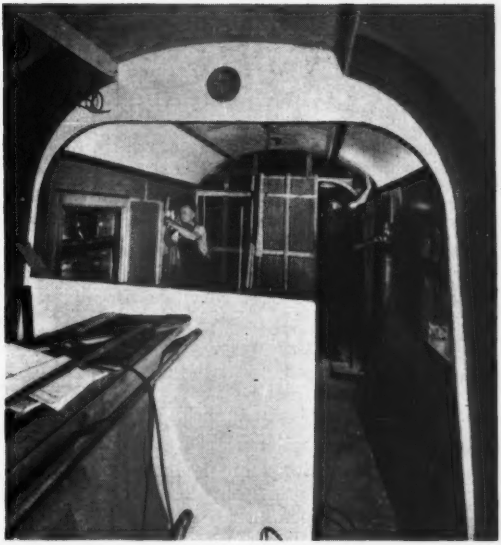
to the full. Advantage has been taken, for instance, of the ability to incorporate artists' drawings or patterned fabrics in the surface of the sheet, both in the treatment of the bar top and wall surfaces.

Entering the coach from either end, the vestibule is surfaced with grey Warerite wall panels. At one end of the coach is the lounge section which is provided with a narrow settle round three sides of the wall, served by two elliptical tables, which are also faced with Warerite material. The fabric upholstery on the settle is a pink and white-patterned asbestos material. This same fabric is repeated in the wall surface by being pressed up in the Warerite sheet during manufacture. This panelling is carried up to ceiling height and all junctions are masked with hardwood strips in natural oak. Some relief is given to the pink-and-white motif here by a narrow surround to the window frames in grey panelling. The curtains at the windows are in translucent vinyl material which is not only æsthetic looking but easily washed.

Dividing the lounge section from the main bar is a partition a little under 4 ft. in height, surmounted by a sheet of "Perspex," affording good visibility between the two sections while retaining some semblance of privacy in the lounge section. The walls of the bar compartment are in alternate grey and pink vertical panels. The background colour of each panel is emphasized by a simple design consisting of pencilled parallel lines in dark grey and pink respectively.

These panels follow a continuous sweep from floor to ceiling, taking a radius in their approach to the ceiling of about 2 ft. The method of construction adopted for this purpose was first to build a timber framework to the walls of the coach on which the Warerite panels are mounted by screwing. The junctions

The lounge section of the buffet car in pink and white. Curtains and lighting fittings are also of plastics.



The installation of the Warerite wall panels during construction.

between panels are as before, masked with natural oak strips.

The bar itself is faced with the same material in grey and the front is concave, so providing a continuous, easy-to-clean surface, and at the same time affording plenty of legroom for those standing at the bar. In this case, the Warerite panels are curved throughout their width. This aspect of the design is interesting, since the continuous line obtained is pleasing to the eye, while from the hygienic point of view no corners or other crevices are formed for the accumulation of dust and dirt. The top of the bar is faced with cream Warerite panels retained in position by inconspicuous aluminium angle pieces. This Warerite material is "blisterproof" and will withstand contact with burning cigarettes, which assumes very great importance in modern bar treatment. Throughout the full length of the bar, which is approximately 20 ft., appears a pencil drawing of an old-time locomotive and carriages, complete with passengers and an excited dog in process of outstripping the train. This original drawing was made on special impregnated paper supplied by the plastics manufacturer and was then pressed up into the laminated plastics sheet during production. As a result of this method of fabrication, the design is permanently preserved by the film of resin which forms over its surface.

In the building of the bar this same method of constructing a timber framework was first adopted. There were five longitudinal battens at approximately 9-in. spacing and vertical battens at intervals of approximately 3 ft. 6 ins.

The wall treatment behind the bar is similar to that facing it, but terminates at its upper extremity in a continuous channel lighting fitting of frosted plastics material. The transverse partition at the exit end of the bar is cream and has let into it a small showcase of clear plastics material. The exit to the coach is panelled with grey Warerite sheet in the same way as the entrance vestibule, already discussed. Showcase and lighting fixtures are of Perspex worked by Thermoplastics, Ltd., of Dunstable.

Altogether, the design is one which is essentially practical and pleasing. It is modern without being aggressive and achieves an air of spaciousness which is attributable probably to the lighting scheme as well as to the bold lines of the design. The car has undoubtedly created a precedent which will be followed in many other aspects of British rolling-stock design.

The Silicon Plastics (continued)

By E. E. HALLS

In the April issue of this journal the Author described the uses of the Silicones in electrical engineering and the work in America on design factors connected with this material.

IN stating that the silicones should be reserved for specific proved applications, De Kiep, Hill and Moses conclude as follows:—

1. Tests on silicone resins, treated materials, and wound apparatus show that the silicone technique:—

(a) Provides an unusually high order of thermal endurance.

(b) Entails relatively minor changes to process, principally those of baking temperatures.

(c) Permits high temperature ratings of certain types of apparatus.

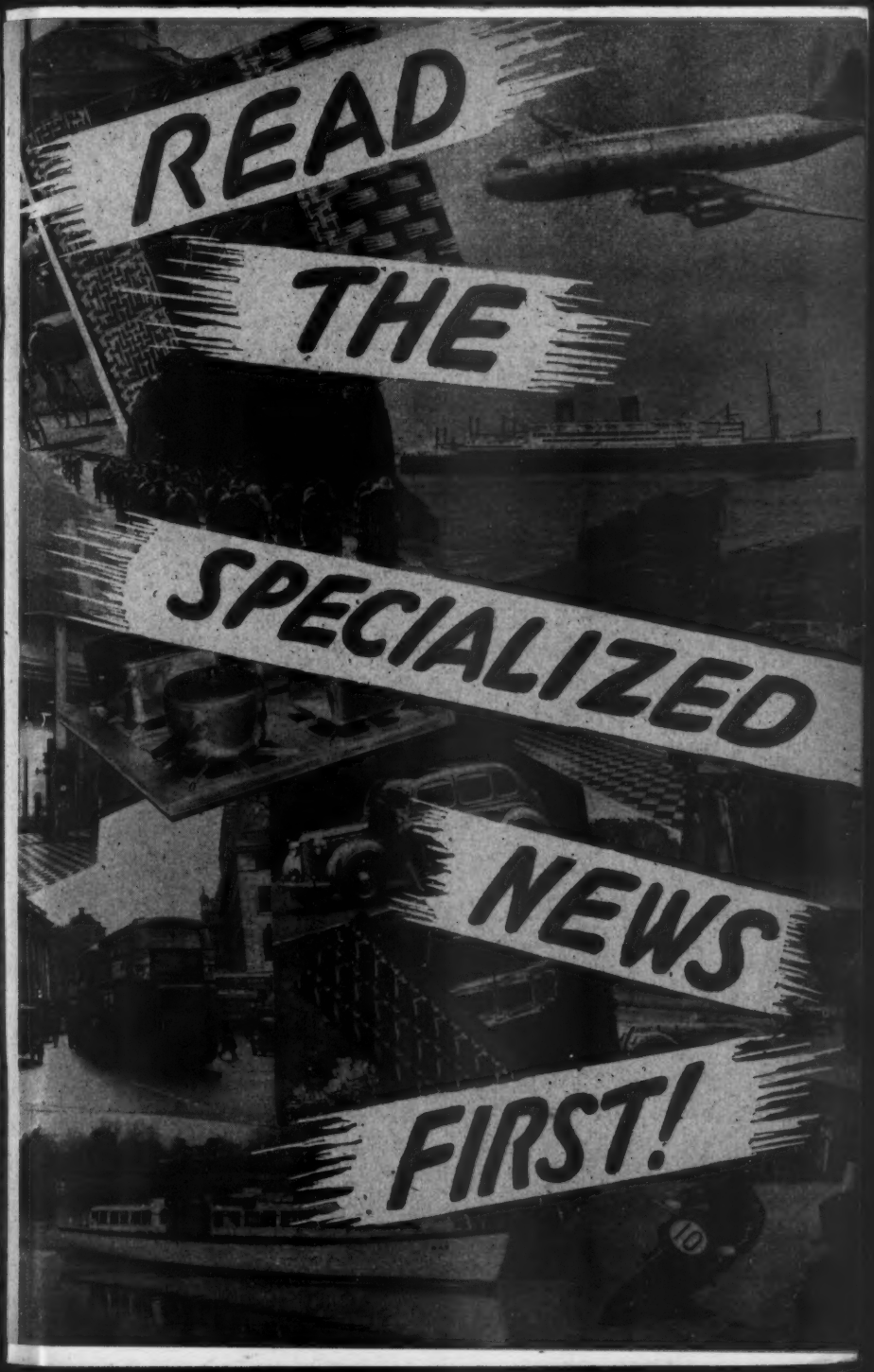
2. Silicone resins and silicone bonded composite insulating materials promise considerable improvement in the thermal endurance of electrical insulation. A conservative estimate of 50 to 75 degrees C. over conventional class B insulatings is given.

3. A recommendation is made that silicone insulation is recognized by a new classification in A.I.E.E. standards, and that tentatively a limit be established for this insulation at 40 degrees C. above the present observed temperature (by resistance) for class B. Also, an increase in hot-spot allowance of 5 degrees C. is suggested and that the limiting hot-spot temperature for high-temperature silicone insulation be set at 170 degrees C. (130 degrees C. is the limit for class B).

The silicone products are treated from another angle of electrical application in "The Proceedings of The Institute of Radio Engineers," July, 1945, Vol. 33, No. 7, p. 441, by Shailer L. Bass and T. A. Kauppi, both of the Dow Corning Corpn., under the heading of "Silicones: A New Class of High Polymers of Interest to the Radio Industry." They summarize these new organo-silicon-oxides as liquid dielectrics, electrical sealing compounds, insulating varnishes, and many other forms in which organic dielectrics are known. They state that the liquids are low-loss dielectrics over a wide-frequency spectrum and are used to waterproof ceramic surfaces to prevent leakage at high humidities. The sealing compounds are used to exclude moisture from disconnect junctions in aircraft ignition systems and are useful in radio components for the same purpose. The resins in the radio field are natural complements to inorganic insulants such as mica, fibrous glass, and asbestos, and can provide insulation to withstand long overloads at severe humidities or high operating temperatures. Where the information already given can be augmented, abstracts are given below apt to the radio field.

Radio apparatus has depended upon organic and inorganic dielectrics. The organic ones, used in a variety of physical forms, include moulded plastics, wire coatings, potting compounds, cements, liquid and wax impregnants. When service conditions require stability at elevated temperatures, the organic dielectrics soon reveal a limit of usefulness. As in the electric motor field already dealt with in detail, rate of ageing is determined by the time period for failure to meet test with respect to a particular physical property, e.g., flexibility, and it quite closely follows the rule of half the life for every rise of 10 degrees C. in temperature. The ultimate decomposition product of an organic dielectric is carbon., i.e., a non-conductor becomes a conductor.

The inorganic materials which include quartz, vitreous silica, glass, asbestos, mica and ceramics, and which are much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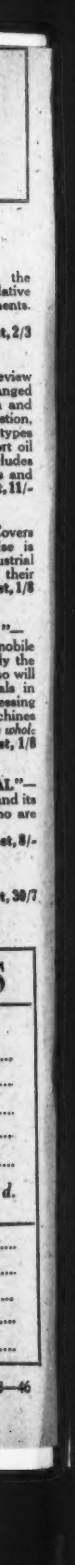

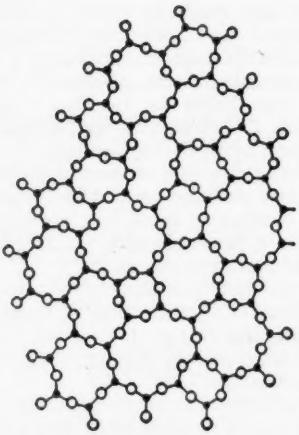

Fig. 7.—Structure of vitreous silica (Moore, "Chem. and Ind." p. 1027, Nov., 1939).

relied upon in radio communication equipment, are all based chemically and structurally upon a framework of atoms of silicon and oxygen. All these materials are really high polymers, large molecules, with the silicon atoms bonded through oxygen atoms. Their heat stability is this silicon-oxygen-silicon bonding; their limitation is the restriction in physical condition to relatively hard brittle solids.

The Daw Corning Co.'s silicone products (11, 12) have been evolved to emulate the ease of manipulation or application of the organic dielectrics and to embody the thermal stability of the inorganic materials. They are organo-silicon-oxides, inherently containing the heat resistant silicon-oxygen-silicon bonding. They cover the forms cited above as necessary for the radio industry.

The interlacing structure of silicon and oxygen atoms is represented by that for vitreous silica as illustrated in Fig. 7, which shows types of silicon-oxygen linkages in two dimensions. This demonstrates both the complexity of the structure and the infinite possibilities. It is not surprising that the researches on silicones were an outgrowth from research in glass, stimulated by the possibility of obtaining glass-like plastics at the Corning Glass Works.

The liquid silicones illustrated in Tables 1 and 2 (see April issue), covering the physical properties of the Dow Corning type 500 and type 200 fluids respectively. They are supplied to specifications with viscosity limits within 5 per cent of the rated viscosity at 24 degrees C., heat stability of less than 5 per cent. viscosity increase after 96 hours at 160 degrees C., and volatility less than 2 per cent. weight loss after 48 hours at 200 degrees C. (except that volatility limits apply to viscosity grades 20 centistokes upward). Fig. 8 shows the very low temperature coefficient of viscosity for the materials of Table 1, and the still lower values for those of Table 2. Some petroleum oils are included for comparison.

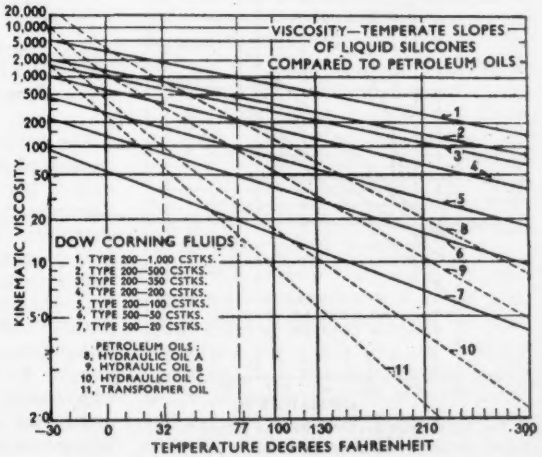

Fig. 8.—Viscosity temperature relations of silicones and petroleum.

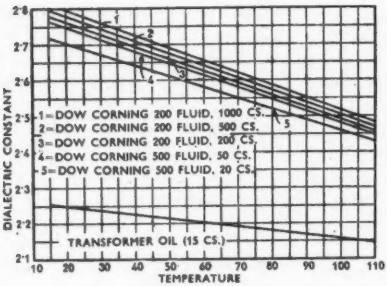

Fig. 9.—Comparative effect of temperature on dielectric constant.

Fig. 9 shows the effect of temperature upon dielectric constant, with transformer oil for comparison, and Fig. 12 upon power factor, again with a hydrocarbon oil for comparison.

All these liquid silicones tend to wet and adhere preferentially to siliceous surfaces and the non-volatile higher viscosity types can be rather permanently absorbed. For use to induce water-repellency on ceramic and glass surface, the articles treated must be scrupulously clean. Articles are best treated direct

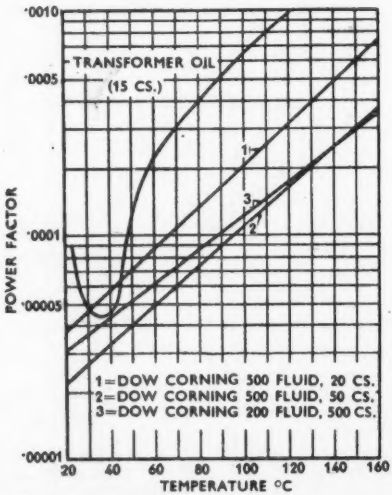

Fig. 10.—Comparative effect of temperature on power factor.

from the annealing ovens, preferably while still warm. They are treated in the non-volatile silicone dissolved in a non-inflammable solvent, allowed to drain, and then baked for two hours at 160 degrees C., which fixes the silicone film on the surface of the insulators.

The silicone film of these highly water-repellent surfaces, under high humidities and condensing conditions, prevents the moisture from forming a continuous liquid film over the surface.

Tests show that the surface resistance of insulators, when freshly treated, is infinite, and that it stays at high values over long periods of time even under immersion in water.

The heat-stable silicone greases, apart from use as moisture-proof sealing media for disconnect junctions of aircraft ignition systems, and to prevent corona from cutting the insulation, are useful as lubricants and protective media on shafts and moving parts of radio equipment, e.g., variable condensers, geared mechanisms of remote control, coil sliders, etc. They are mould resistant, and by their moisture-proof sealing, impart mould protection to the components concerned.

For coil impregnation, the authors cite the following conditions:—

(1) After impregnating, allow the solvent to dry off.
(2) Give an intermediate baking of 2 to 4 hours at 150 degrees C.
(3) Cure for 1 to 3 hours at 250 degrees C. until the varnish becomes tack free.

The hard silicone mass which results is claimed to be still flexible, and not only is it moisture proof, but it is not deteriorated by oils and is resistant to chemicals. The flexibility of this type of resin is shown by the thermal endurance test results graphically expressed in Fig. 11. Organic varnish and Dow Corning 993 resin are included in this. The curves show that the rate of reduction in flexibility of the varnish films with change in temperature is approximately the same for both organic and silicone varnish films, i.e., to reduce the

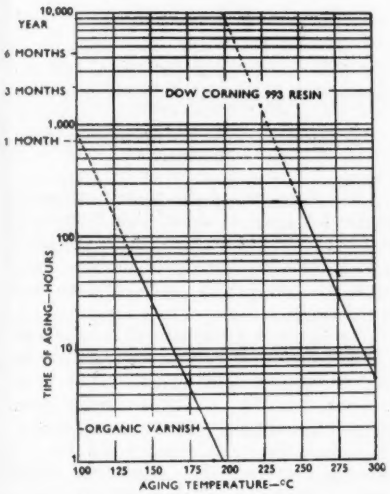

Fig. 11.—Thermal endurance of silicone insulating resin compared with high quality organic insulating varnish.

elongation of the resin film to a degree at which the coating cracks when bent over a $\frac{1}{8}$-in. mandrel, the time required on the thermal ageing test is roughly halved for each 10 degrees C. rise in temperature. It is to be noted that the silicone ageing curve is 100 degrees C. higher than that for the organic varnish. Under normal operating conditions, longer life is secured from the silicone insulation or a higher operating temperature is permissible for the same service life.

This greater thermal resistance of the silicone insulation means longer resistance to ageing, longer period before water and moisture-proofing properties becomes deteriorated to a level that impairs electrical efficiency, longer period before loss of flexibility causes dangerous embrittlement, and longer period before insulation resistance falls off to a serious level. Bass and Kauppi, therefore stress the advantages of silicone insulation not only to permit of increased horse-power for a given size, and to permit of greater freedom from overload failures, but also for prolonging life of electrical equipment in locations that are hot, wet or severely corrosive. They are also capable of withstanding mechanical stresses of vibration, impact and the like.

The thermosetting silicone resins are supplied in solution form for bonding and laminating purposes. Fibre glass and asbestos textiles can be bonded to themselves or to mica. The material is impregnated or coated, and the treated cloth or sheet is then bonded to produce the laminate in the usual type of press, but at the relatively high temperatures of 230 to 250 degrees C. About an hour's curing time is necessary, but the press time can be less than this, and the curing completed at the same temperature in an oven. These resins for laminates are similar to the phenol-formaldehydes in that they pass through a thermoplastic stage, but they differ in that conversion to the final heat-hardened condition proceeds much more slowly. This is an important stage, the rate of final cure determining the properties of the resultant piece to some extent. Generally, the longer the cure the better the flexibility.

Regarding the use of silicone liquids for providing water repellency to ceramic insulators, for which purpose there is a real need for an efficient medium and the silicones appear to be eminently suitable, Bass and Kauppi mention the use of organo-silicon chlorides which have been used for the same purpose. U.S. Patent No. 2,306,222 (W. I. Patnode and General Electric Co.) covers this field. These chlorides hydrolyse in the presence of moisture to give hydrochloric acid and a silicone. At first sight, the process of their application would seem to be objectionable for electrical components. A loss of insulation would be expected if the acid is not completely removed, and corrosion possibilities would be anticipated. From America complete success has been reported, and application in practice appears to have been quite extensive. The materials are not available in this country, and what trials have been made are understood to have been a failure, with

reduced insulation and corrosion as forecast. These adverse results may be accounted for by failure to acquire the correct technique in application. Much more confidence can be placed in the silicone liquids, not only for the radio industry, but in other electrical fields as well. However, by no means the last of the organo-silicon-halides has been heard. Much important detail was given in The General Electric Review, August, 1944, Vol. 47, No. 8, p. 6, in an article entitled "Organo Silicon Films," by Dr. Francis J. Norton, of the G.E.C. Research Laboratory. The trade mark of the G.E.C.'s water-repellent compounds is "Dri-Film." Norton shows how dri-film greatly increases the resistance of ceramic insulators to electrical surface-leakage under conditions of high humidity and dewpoint condensation, and explains the critical conditions for the application of the film. The following information is taken from this source.

Norton used a mixture of crude methyl chloro-silanes to produce water-repellent surface treatment. The vapour pressure of this material at room temperatures of 25 degrees C. is about 200 mm. The vapour of the Chloro-Silane reacts very rapidly with the moisture absorbed on the surface to be treated. Hydrochloric acid is split off, and a thin water-repellent film is left deposited on the surfaces where this reaction has occurred. The hydrochloric acid is said to evaporate rapidly from the ceramic surface, leaving the non-volatile layer that gives the water repellency.

Norton suggests the reaction with water proceeds as shown in Fig. 12, and suggests that the methyl (CH_3-) groups present a hydrophobic surface which water has little tendency to wet (13).

Normally all surfaces have absorbed water molecules, the number depending upon the relative humidity, and the nature of the surface (14, 15). For water films on Silica, Parks found a thickness of 13×10^{-6} cm. in equilibrium with saturated water vapour at 15 degrees C. Briggs found 0.45×10^{-6} cm. at 80 per cent. and 2.7×10^{-6} at 99 per cent. relative humidity. Using $3\text{Å} = 3 \times 10^{-8}$ cm.

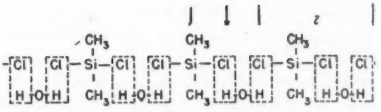

Fig. 12.—Reaction of methyl-chloro-silane with water.

as the diameter of the water molecule, the water layer at these high humidities is about 100 molecules thick. Other values for crystalline solid surfaces have been determined by Jans, Brooks and Boyd (16).

For the best treatment of steatite surfaces, Norton states that they should be in equilibrium with 50 to 90 per cent. relative humidity. The methyl-chloro-silane vapours should not be applied if there is visible condensed water on the ceramic surfaces. The condensed water would result in thick, isolated, non-uniform patches of the hydrolysis product; pre-conditioning at 50 to 90 per cent. humidity is found to be satisfactory.

The water-repellent film produced on steatite under these conditions is exceptionally thin. For example, a ceramic coil former of surface area of 400 sq. cms. gained 0.0075 gms. on treatment, or 1.8×10^{-5} gms./sq. cm. Using a film density of unity, the film thickness is 1.9×10^{-5} cm. which is less than the wave length of visible light.

Norton also estimates the film thickness from large-scale information. About 800 coil formers can be treated in a 40-cubic-ft. cabinet by 25 c.c. of dri-film methyl-chloro-silane, or 28 gms. This yields about 16 gms. of deposited material over 320,000 sq. cm. or 5×10^{-5} gms./sq. cm. giving a thickness of 5×10^{-5} cm. for the film, if it is uniform and of density 1, and if the efficiency of application is 100 per cent.

Fig. 13 shows the formal representation of the silicone which forms the

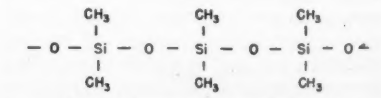

Fig. 13.—Representation of silicone.

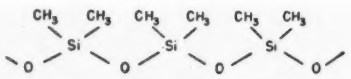

Fig. 14.—Probable arrangement of silicone molecule in space.

water-repellent layer. This does not represent the actual spacial orientation of the constituent atoms. A reasonable orientation is given in Fig. 14, which yields a molecule having a closely packed surface consisting of methyl groups, forming the water-repellent hydrophobic surface, characteristic of chloro-silane-treated ceramics. The silicone and oxygen atoms of the silicone are bonded to the underlying silicate surface by subsidiary valence forces.

Calculated from models, the area theoretically covered by one molecule of $(CH_3)_2SiCl_2$ that reacts to form one (CH_3SiO) unit can be calculated. The methyl groups are the deciding factor in the spacing, and they are about 3Å apart from carbon atom to carbon atom. The chains can be 4Å from one another. The area is 3(3+4) or 21 sq. Å per molecular unit of two methyl groups, one silicon atom and one oxygen atom. The molecular weight of dimethyl dichloro silane is 129 gms. Taking Avogadro's number as 6.023×10^{23} molecules per mole, the area per mole is $21 \times 10^{16} \times 6.023 \times 10^{23}$ or 1.26×10^{9} sq. cms. or 1.26×10^{5} M^2 per mole, i.e., about 1,000 M^2 per gram of the material applied for a monomolecular layer on the surface.

The thickness of the monomolecular layer of silicone of the orientation shown in Fig. 14 is about 6A or 6×10^{-8} cm.

A laboratory method for applying the methyl-chloro-silanes is to prehumidify the ceramics if necessary, and place them in a glass vessel with inlet and outlet tubes. The silane is fed in bypassing dry air through two or three bottles of the silane. This ensures closest equilibrium and constant composition from the last bottle when several silanes are employed in admixture. Only a few minutes' exposure is necessary because of the rapidity of hydrolysis, and this time gives all that is required for diffusion of vapours to all parts of the ceramic. The treated parts are next aired to allow the hydrochloric acid to vaporize. Most of the acid is gone in 10 minutes and two hours of airing is said to be ample, but further improvement is noted in electrical characteristics on aging beyond 24 hours.

Recommendations for the handling of methyl chloro silanes are given, because contact with the skin causes hydrolysis and the formation of hydrochloric acid there, and inhaling the vapours produces the acid internally. A good hood with exhaust to take vapours away, and no naked lights, are advocated. No cumulative toxic effects have yet been reported.

Figs. 15 and 16 show the wooden cabinet equipment for large-scale treatment. The ceramics are stacked in wooden trays painted with phenolic resin-base varnish and having bases consisting of Saran screens. The cabinet is about 70-cubic ft. capacity and is provided with closed circuit air circulation. The methyl chloro silane is introduced into this system by having a glass dish on a hot-plate and dropping 50 c.c. of the liquid into it, maximum temperature being 150 degrees C.

Vapour concentration calculations are made for efficiency and fire-risk reasons; 50 c.c. of liquid is 56 gms., or 0.434 mole, equivalent to 9.7 litres of vapour at N.T.P. or 10.7 litres under room conditions. This is 0.54 per cent. of volume concentration in the cabinet. The lower inflammability limit is 3.4 per cent.

After a 20-minute treatment time, a tight damper in an exhaust pipe is opened and the residual vapours, which contain hydrochloric acid, are blown to atmosphere for 10 mins. The treated components are then removed, given a two-hour period of airing, and they can be passed to assembly or store.

For assessing the value of the treatment under the most severe conditions, electrical surface leakage was measured during condensation of liquid water drops

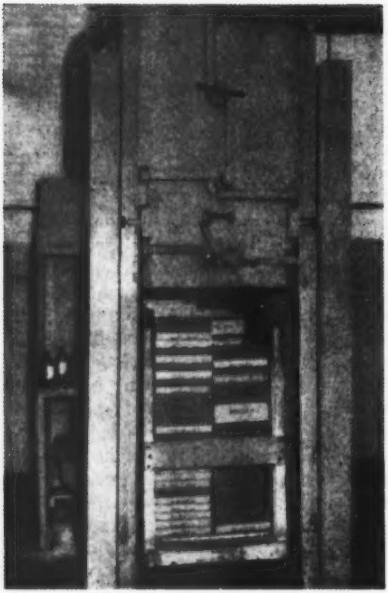

Fig. 15.—Cabinet (open) for chloro-silane vapour treatment of ceramics.

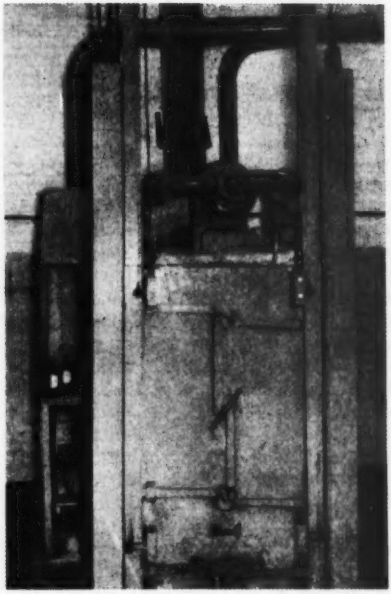

Fig. 16.—The cabinet closed. Note circulating ventilating systems.

on the ceramic surface. The parts were frozen to −10 degrees C., and then transferred to a controlled atmosphere of 100 per cent. humidity at 25 degrees C. Electrical tests were made at 500 volts D.C. using a megohm bridge, the leads from the latter passing through long glass tubes into the humidity chamber. This provided long leakage paths, but also the glass was protected by methyl-chloro-silane treatment.

Under these test conditions the surface resistance of the specimen generally fell within 1 min. and continued to drop for 5 to 10 mins. This lowest reading was recorded as the resistance value under dew-point conditions. Again, after several hours at 25 degrees C. in 100 per cent. humidity, the surface resistance would gradually rise somewhat, and continue to rise until all liquid drops of water disappeared. The value then would be the surface resistance at 100 per cent. humidity without condensation. The lowest value always accompanied visible condensed water, and the general appearance of the moisture film paralleled the electrical resistance of the surface under dew-point conditions.

On materials rendered water repellent by means of methyl-chloro-silanes, water condenses in very tiny droplets, velvety in appearance, the drops standing up with high-contact angle. They are not in contact with one another, and the electrical surface resistance is high. Untreated surfaces, whether glazed or unglazed, acquire large droplets or large wetted areas with poor electrical surface resistance. This is shown in Fig. 17, in which at very high magnification the isolated drops at high contact angle on treated surfaces are shown on the left, and the large wetted areas on untreated ceramic are portrayed on the right. It is pointed out that waxed surfaces occupied an inter-

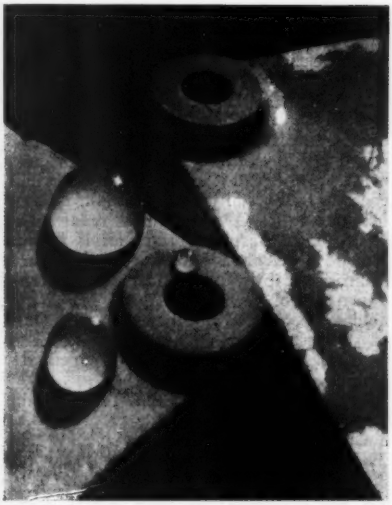

Fig. 17.—Enlarged water droplets on chloro-silane-treated ceramics and (right) spreading of water on untreated material.

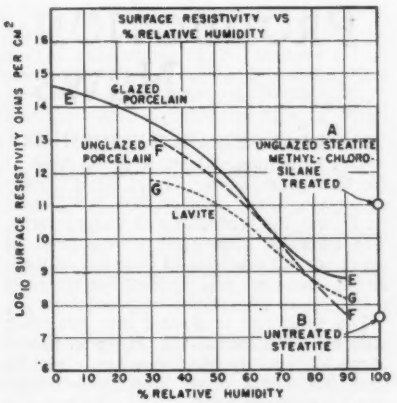

Fig. 18.—Variation of surface resistance of ceramics, with relative humidity (H. L. Curtis, Bulletin of the Bureau of Standards, II, 359, 1915) measurements inside dew-point conditions.

mediate position with medium-sized droplets and intermediate electrical resistance.

Curtis carried out extensive work on surface-resistance measurement (17, 18). Fig. 18 uses his data for glazed and unglazed porcelain, and for lavite, at different humidities, and on the 100 per cent. humidity line, Norton enters his results for steatite (similar base to lavite), unglazed and with and without methyl-chloro-silane treatment. The value for unglazed steatite, untreated, fits into the extension of Curtis's curves. The treated sample at 100 per cent. humidity has approximately the same resistance as lavite at 50 per cent. or porcelain at 60 per cent. humidity.

(To be continued)

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PLASTICS IN THE LABORATORY

(Continued from p. 231).

the plastics mentioned). Plastics, generally, are rather lighter in weight than glassware (wall thickness being equal).

Additional note: Handles for taps upon the laboratory bench, moulded in contrasting colours and bearing the description of the service, i.e., gas, compressed air, vacuum and water, offer greater safety in eliminating the danger of opening the wrong tap.

The author especially thanks the laboratory furnishers, Townson and Messer, Ltd., J. W. Towers and Co., Ltd., and Griffin and Tatlock, Ltd., for valuable information.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

CHEMICAL RESEARCH EXHIBITION

This exhibition, which is to be held at the Tea Centre, Lower Regent Street (corner of Jermyn Street), London, S.W.1, will open on June 5, the Wednesday of Victory Week. The exhibition is designed to show some of the major achievements of chemical research during the war, and to demonstrate their even greater importance in peace time.

The exhibition is divided into five main sections, each based on a great British chemical discovery which is not only notable scientifically but offers great potentialities for the common weal.

The section "The Chemist versus Disease" is devoted to the part played by chemical research in combating disease and improving sanitation, conditions of a century ago being contrasted with those of to-day. Particular emphasis is laid on the sulpha drugs, penicillin and Paludrine (the latest and greatest anti-malarial).

"The Chemist and Your Food" outlines the part played by the chemical industry in modern agriculture. Though this section naturally deals with synthetic fertilizers, it is mainly concerned with the evolution of chemical methods for combating moulds, bacteria and weeds. The new selective weed-killer, Methoxone, is the highlight, and the story of this discovery, development and use is illustrated with models, diagrams and photographs.

Chemical warfare against predatory and disease-bearing insects has a section to itself. The new insecticide "Gammexane" is described in detail with the help of historical montages, a display of specimens, and molecular models of the four isomers of benzene hexachloride. Lists show the numerous pests—domestic, industrial and agricultural—to which the toxicity of "Gammexane" is already proved.

The section on "The Chemist and Plastics" centres round "Perspex" and polythene, two of the greatest recent discoveries in the field of plastics. The history of "Perspex" is summarized, and a molecular model illustrates the process of polymerization of methyl methacrylate. "Perspex" exhibits include noses, shields and turrets of aircraft, corrugated sheets for roof lighting, surgical and dental equipment, prisms and lenses, as well as a large number of domestic articles. The polythene exhibit will give many people their first opportunity of seeing this latest achievement of British chemistry. Special displays explain its contribution to the development of radar. The value of its electrical properties is further shown in telephone, radio, television and submarine cables. Exhibits show its use as a waterproof packing material for drugs, notably mepacrine, and for a large number of domestic and industrial applications, including acid-proof containers, funnels and piping.

The final section is devoted to Ardil, the wool-like protein fibre made from monkey nuts. The underlying chemical theory is illustrated by diagrams and models showing the breakdown of proteins into amino acids, and the reassembly of these into proteins of a different nature. This is followed by a demonstration of the process used for the manufacture of Ardil, and exhibits of fabrics in which Ardil is combined with wool, cotton and rayon.

The exhibition, which is organized by I.C.I., is being produced by Mr. Galvin Wright. The architect is Mr. Basil Spence. It will be open daily from 10.30 a.m. to 8 p.m. (Sundays 2 till 7 p.m.) until June 28 inclusive.

A charge of 1s. will be made for admission, and all proceeds will be given to the Empire Fund for Cancer Research.

JENSEN AND NICHOLSON, LTD., of Carpenters Road, Stratford, London, E., has issued a leaflet describing "Solventless," a new impregnating medium containing no solvent. The varnish is a new synthetic thermo-setting varnish, which is stoved at 300 degrees F. to secure polymerization. This should prove of great interest to the electrical industry.

PLASTICS INSTITUTE OF AUSTRALIA has decided to make an annual award for the best paper submitted each year upon any subject having a relevancy to matters affecting the plastics industry. It is proposed to award a plaque of special design to the person submitting the prize-winning paper. Entry forms may be obtained from the Secretary, Wingello House, Angel Place, Sydney, N.S.W.

U.S. STYRENE.—The Office of Rubber Reserve, Reconstruction Finance Corporation, acting on recommendations made by the Civilian Production Administration, has decided to make available for consumers outside the rubber industry such quantities of monomeric styrene as may be produced in excess of the requirements of the government's synthetic rubber programme. This will be sold in tank car lots at 13 cents a pound. It is reported that the U.S. Koppers plant has gone into production with styrene, possibly intended for Buna S polymerization plants and polystyrene plastics makers.

D.S.I.R. EXPENDITURE.—The Department of Scientific and Industrial Research estimates its expenditure for 1945-6 to be £1,817,217 and for 1946-7 to be £2,711,567.

SUNVIC TECHNICAL PUBLICATION.—We have received from Sunvic Controls, Ltd., a description of the proportioning head made by this firm for fitting to standard toluene regulators for thermostatic control. Copies can be obtained by writing to Stanhope House, Kean Street, Aldwych, London, W.C.2.

PLASTICS EXHIBITION.—In association with the British Plastics Federation, the "Daily Sketch" will hold a plastics exhibition at the Dorland Hall, London, in November.

B. LAPORTE, LTD., of Luton, chemical manufacturers, with their associated companies, National Titanium Pigments, Ltd., and Genoxide, Ltd., have opened a sales office at 17, Cadogan Street, Glasgow, C.2, to cope with their increasing sales in Scotland.

ASSOCIATED LEAD MANUFACTURERS, LTD. (Home Sales Dept.), previously located at their emergency war-time address, Limpsfield Court, Oxted, Surrey, have now returned to London, and all future Home Sales inquiries should be addressed to their new offices at 12-15, Finsbury Circus, London, E.C.2. Telephone: London Wall 4394.

The Buying and Alloy Departments have also removed from 17, Waterloo Place, S.W.1, to the above address, which will now serve the London Home Sales and Alloy Sales and Buying Departments of the constituent companies.

DR. NICKELL, Chairman of Monsanto Chemicals, has been the recipient of the cordial recognition, by the workers of the company, of his work in promoting their general welfare. He was presented at Ruabon with his portrait painted by Mme. Rotinoff.

PITTER GAUGE AND PRECISION TOOL CO. announce that Col. D. R. Johnson has been appointed Sales Manager of the company. After wide experience in the R.A.O.C. and R.E.M.E., he took over control of the Inspectorate of Fighting Vehicles Testing Station at Farnborough in July, 1944.

REED BROS. (ENGINEERING), LTD., announce that they have just occupied a new works situated at Cuba Street, Millwall, London, E.14, which they have recently purchased. The premises have a total floor space of 20,000 square feet, equipped with overhead travelling cranes suitable for handling heavy machinery. A machine shop of adequate size is being installed, including lathes which will take up to 30 ft. long and a planing machine 16 ft. by 6 ft. by 6 ft. This will enable them to deal adequately with their rapidly expanding business of reconditioning, converting and manufacturing hydraulic, plastics and rubber and chemical plant and machinery. Correspondence should continue to be addressed to their City office at Bevis Marks House, E.C.3.

RHYMNEY ENGINEERING CO., LTD., has been formed to develop and market the latest mechanical processes for winning coal. The company will be jointly owned by Powell Duffryn and International Combustion. The first directors are Edmund Hann, chairman, and Sir George Usher, deputy chairman, Mr. F. G. Penny, M.I.Mech.E., M.I.C.E., and Mr. Ivor Williams.

The company intends to exploit the latest processes developed in Great Britain, the United States, Germany and Holland.

Society Meetings

The 14th Annual General Meeting of the Plastics Group of the Society of Chemical Industry will be held at Stewart's Restaurant, 50, Old Bond Street, London, W.1, at 5 p.m. on Thursday, May 23. At 7 p.m. at Burlington House, Piccadilly, London, a paper will be read entitled "The Tropical Behaviour of Cellulose Acetate Films," by N. J. L. Megson and A. K. Unsworth with V. E. Yarsley and W. J. Grant.

BRITISH PLASTICS FEDERATION LUNCH

On April 10, 1946, at the Savoy Hotel, London, the British Plastics Federation held what must have been the most brilliant luncheon party in its history. The meeting was honoured by the presence of the Rt. Hon. the Lord Mayor of London and his Sheriffs, the Rt. Hon. Mr. Oliver Lyttelton, the chief guest of the evening, and many representatives of the country's great industries and of the Government.

In his speech of welcome to the distinguished guests, the Chairman of the Federation, Mr. H. W. Graesser-Thomas, referred to the progress made during the difficult years and to the part the industry had played in this last most technical of wars, on the seas with the Navy, in the field with the Army, and in the air with the Air Force. He referred, also, to the part played in peace-time, to the collaboration with the electrical industry, and to the uses of plastics in motorcar manufacture, and in the construction of railway carriages and trucks. Of the future he was optimistic, and continued:

"We are straining at the starting gate, eagerly anxious to join in the race of the export stakes and deliver our share of the prize money to the Nation for the purchase of food. We, like other industries, are hampered by the lack of new tools, owing to the calling up of our skilled toolmakers. I regret to tell you that our representations to the Government on this score—to us so vitally important—have so far fallen on deaf ears.

"I would remind you especially that for six long, weary years of war more than 95 per cent. of the total plastics production of this country has gone either directly into the forging of weapons of war, or passed into the hands of the various Government Departments for the furtherance of the war effort. Imagine, therefore, the terrific transition problem that now confronts us—the new plant and equipment, particularly new tools and moulds, which must be brought into being before we can put to practical accomplishment the wealth of knowledge, experience and enthusiasm which our members possess. We have the markets, we have the will power and the skill power, and we feel we are more than fully entitled to expect the understanding, support and collaboration of our Government.

"Our members will take advantage, in the usual full measure, of the opportunity provided by Trade Exhibitions to place their wares before their consumers; but there is another type of Exhibition—if, indeed, such a word is appropriate to the occasion—which I should like to mention. This concerns the link between the industry, through the Federation, and the Worshipful Company of Horners. A joint committee has just been formed, which could better be described as a team of artists or designers, who will paint a picture on a canvas covering centuries, which will breathe the spirit of British energy, enterprise and accomplishment from the ancient handicrafts of the Horners down on through the ages to the magic of the modern machines. This Exhibition—let us use the modern term—will be held in one of the ancient city halls, and will, we hope, receive the patronage of the Right Honourable the Lord Mayor."

In reply to the toast of welcome to the guests, Mr. Oliver Lyttelton paid a great tribute to the work of the industry and the Federation, and made a special plea for improving design in industry.

He instanced the plastic industry as part of the new march of science, in which we were creating wonders and the provision of all things to everybody with a minimum of labour, and urged the necessity of teaching ourselves the need of understanding leisure and of using it. The engineers and chemists were making the most astonishing devices and machines, but we pay far less attention and devote far too little intelligence to how they are to be used. Every year we make the telephone better, and every year we use it less well. The new Rolls-Royce, which will sell at about £4,000, will be capable of 90-100 miles an hour, and yet it will, perhaps, be the slowest means of getting from the Bank of England to Charing Cross.

It is quite ridiculous to use the equipment, the apparatus and the facilities of the 20th century with a 19th-century mind. Man must learn to educate himself. When he has done this, Mr. Lyttelton said, we shall also banish hunger, and we shall live without the desire of destroying one another.

"It is quite certain," he concluded, "that you here have made, and will make, a great contribution to the leisure upon which I have tried to let my imagination play. This afternoon I enter the plea, indeed the prayer, that we should all, by precept and example, begin to play a part in a more lively fashion in the fundamental problems, in the economic field, how to exchange our wealth amongst ourselves, how to use it, how to use our leisure, how to re-establish the elegancies of life, and—in the wider field—how to protect our society and our civilization from the impact and appalling tragedy of strife and of war."

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 574,482. Application date: 24.12.42. Accepted: 8.1.46.

Polymerisation of Vinyl Chloride. R. G. R. Bacon, L. B. Morgan and W. B. Whatley. To: Imperial Chemical Industries, Ltd.

Modification of B.P. 573,366. The modification consists in the employment of water soluble thiosulphate with the purpose of taking up molecular oxygen.

B.P. 574,488. Application date: 5.7.43. Convention date (U.S.A.): 9.7.42. Accepted: 8.1.46.

Improvements in or relating to the Plasticization of Polyamides, and Polyester Amides. To: E. I. du Pont de Nemours.

Refers to the use of 5-65 per cent. of monohydric alcohol esters such as those of (9)10-phenylol stearic acid (e.g. its methyl ester) as plasticizers.

B.P. 574,606. Application date: 1.12.41. Convention date (U.S.A.): 9.11.40. Accepted: 14.1.46.

Complex Esters and Polymers thereof. To: Pittsburgh Plate Glass Co.

Process for the manufacture of polyesters by esterifying a polybasic acid (carbonic acid) or its equivalent with the monohydroxy carboxylic acid ester of an unsaturated alcohol. Examples of unsaturated alcohols quoted: allyl alcohol and methallyl alcohol. Lactic acid is quoted as an example of monohydroxy carboxylic acid.

B.P. 574,639. Application date: 29.6.44. Accepted: 14.1.46.

Improvements in or relating to Injection Moulding Machines. F. K. Goldhard and D. D. Prenn.

Relates to an improved mechanism for clamping the die plates together during the injection period.

B.P. 574,648. Application date: 26.2.43. Convention date (U.S.A.): 26.2.42. Accepted: 15.1.46.

Manufacture of Unsaturated Hydrocarbons. To: Imperial Chemical Industries, Ltd.

Process for cracking one or more high molecular weight interpolymers of ethylene with one or more polymerizable organic compounds with at least one double bond, at a temperature between 325 degrees and 700 degrees C. at reduced pressure and in the presence of a catalyst.

B.P. 574,653. Application date: 20.8.43. Convention date (U.S.A.): 25.9.42. Accepted: 15.1.46.

Improved Organo-Silicon Compounds and Method of making them. R. F. Fleming, junr. To: Corning Glass Works.

B.P. 574,656. Application date 23.12.43. Accepted: 15.1.46.

Improvements in or relating to the Flanging of Pipes, Conduits and the like of Plastic Materials. G. Haim and H. P. Zade. To: Arc Manufacturing Co.

Method and tool for the H.F. welding of plastic flanges to plastic pipes. Material quoted: Polyvinylchloride.

B.P. 574,657. Application date: 23.12.43. Accepted: 15.1.46.

Improvements in or relating to the Joining of Flanged Pipes and the like of Plastic. G. Haim and H. P. Zade. To: Arc Manufacturing Co.

See also 574,656. Refers to methods for welding together by means of H.F. current flanged plastic pipes of thermoplastic materials such as P.V.C.

B.P. 574,679. Application date: 18.2.43. Convention date (U.S.A.): 18.2.42. Accepted 16.1.46.

Polymeric Esters. To: Imperial Chemical Industries, Ltd.

Manufacture of polymeric esters by heating an aliphatic aldehyde (e.g. formaldehyde) and the monomeric or polymeric anhydrides of a dicarboxylic acid with at least three contiguous atoms between its carboxyl-groups (e.g. glutaric-, adipic, pimelic, sebacic acid, etc.).

B.P. 574,688. Application date: 23.7.43. Convention date (U.S.A.): 23.7.42. Accepted: 16.1.46.

Improvements in or relating to the Poly-

merization of Tetrafluorethylene. To: E. I. du Pont de Nemours.

Relates to the polymerization of tetrafluorethylene at a pressure above 500 lb./sq. in. and at temperatures between 55 degrees and 240 degrees C. in the presence of water and oxygen, ozone or an organic peroxide. The material so obtained is useful for the making of flexible tubing for corrosive liquids, gaskets, packings, diaphragms, bearings, bottle closures, etc.

B.P. 574,713. Application date: 9.3.43. Convention date (U.S.A.): 24.11.42. Accepted: 17.1.46.

Polyamides. To: Wingfoot Corporation.

Process for the production of polyamides by heating dicarboxylic acids (e.g. adipic or sebacic acid) with ethylene bis (3-aminopropyl) ether.

B.P. 574,739. Application date: 6.5.42. Accepted: 18.1.46.

Treatment of Linear Polymers with Formaldehyde or Formaldehyde-liberating Substance. D. A. Harper and R. J. W. Reynolds. To: Imperial Chemical Industries, Ltd.

B.P. 574,790. Application date: 21.2.44. Accepted: 21.1.46.

Phenol-Formaldehyde Resins. W. Charlton, J. B. Harrison and L. E. Perrins. To: Imperial Chemical Industries, Ltd.

Relates to the manufacture of phenol-formaldehyde resins based on O-cresol. The process comprises heating of a mixture of O-cresol with a monohydric phenol (O-cyclohexyl phenol or P-Cyclohexyl phenol) with formaldehyde in the presence of caustic soda as alkaline catalyst.

B.P. 574,804. Application date: 5.1.43. Accepted: 22.1.46.

Improvements in Plastic Materials particularly applicable for the covering of electric conductors. E. W. Mills. To: British Insulated Cables, Ltd.

Plastic compound containing polyvinyl chloride or a vinyl chloride-vinyl acetate copolymer and a plasticizer (55-80 per cent. by weight). Liquid methyl methacrylate or acrylic esters are given as examples of plasticizers which give the compound tackiness and plasticity similar to unvulcanized rubber, so that it can be processed in the same way and with the same machinery as rubber. Subsequent heat treatment (polymerization) converts the material, so that it resembles vulcanized rubber.

B.P. 574,791. Application date: 21.2.44. Accepted: 21.1.46.

Phenol-Formaldehyde Resins. W. Charlton, J. B. Harrison and L. E. Perrins. To: Imperial Chemical Industries, Ltd.

Relates to the manufacture of oil-soluble phenol-formaldehyde resins and comprises heating a mixture of a monohydric phenol, for instance O-Cyclohexyl phenol, ar-tetrahydro-alpha-naphtho with minor proportions of other monohydric phenols (P-tertiary-butyl phenol, P-Cyclohexyl phenol) with formaldehyde in the presence of caustic soda as catalyst.

B.P. 574,863. Application date: 10.12.42. Convention date (Canada): 28.7.42. Accepted: 23.1.46.

Polymerization of Vinyl Esters in Emulsion. M. Kiar. To: Shawinigan Chemicals, Ltd.

B.P. 574,898. Application date: 11.1.43. Accepted: 25.1.46.

Improvements in or relating to Reinforced Rubber Articles. L. R. Herndon. To: E. I. du Pont de Nemours.

Process for manufacturing reinforced rubber articles (rubber tyres and the like) by applying an active hydrogen-containing reinforcing material, an active hydrogen-containing rubber and a polyisocyanate, thiocyanate, or a mixture of both, combining the mix with vulcanizable rubber and subsequent vulcanizing treatment.

B.P. 574,901. Application date: 24.2.43. Accepted: 25.1.46.

Improvements in or relating to Rubber and Rubber-like Materials. G. H. Latham. To: E. I. du Pont de Nemours and Co.

Relates to the modification of aldehyde-modified rubbers by reacting them with diiso-cyanate.

B.P. 574,919. Application date: 4.5.44. Convention date (U.S.A.): 10.5.43. Accepted: 25.1.46.

Improvements in or relating to the Manufacture of Articles of Rubber-like Material. To: International Latex Processes, Ltd.

Manufacture of articles of rubber-like material by direct condensation from aqueous dispersions of rubber-like copolymers of butadiene and styrene.

B.P. 574,956. Application date: 31.12.43. Accepted: 28.1.46.

Improvements in or relating to the Manufacture of Synthetic Linear Polyamide Yarn.

E.I. du Pont de Nemours and Co. To: Imperial Chemical Industries, Ltd.

B.P. 574,971. Application date: 6.12.40. Accepted: 29.1.46.

Improvements in or relating to the Manufacture of Transparent Products. J. R. Myles and L. Snowden. To: Imperial Chemical Industries, Ltd.

Process for the manufacture of flexible and transparent articles by cutting, moulding, calendering or casting chlorinated polythene. Chlorination is carried out in the presence of a chlorine stable medium until the chlorine content reaches 35-70 per cent. by weight. Plasticizers, lubricants, etc., may be added.

B.P. 575,073. Application date: 25.2.44. Accepted: 1.2.46.

Production of cellulose ethers and of articles made therefrom. J. E. Jones, J. H. Sharphouse and J. Downing.

Concerns improvements in the production of cellulose ethers having an improved resistance to heat.

B.P. 575,096. Application date: 26.11.41. Accepted: 4.2.46.

Improvements in the Manufacture of Chlorinated Polythenes. J. R. Myles and P. J. Garner. To: Imperial Chemical Industries, Ltd.

Process for the manufacture of chlorinated polythenes by chlorination in the presence of an inert liquid (carbon tetrachloride) and in the absence of oxygen. The reaction is accelerated by illumination of the reaction zone with fluorescent tubes.

B.P. 575,125. Application date: 30.7.42. Accepted: 5.2.46.

Improvements in or relating to Cellular Materials. W. I. Taylor. To: British Celanese, Ltd.

A material made according to B.P. 575,124, cut to shape, is made waterproof by filling the open spaces on the surface with a film-forming material and a finely divided solid filler (ethyl cellulose, sawdust and acetone are quoted as components of such a filling material). Subsequently the surface of the cellular block is coated with varnish.

B.P. 575,124. Application date: 24.6.42. Accepted: 5.2.46.

Improvements in the production of Thermoplastic Materials in Fibrous or Cellular Form. W. I. Taylor. To: British Celanese, Ltd.

Relates to the production of water-resistant materials of low specific gravity, by subjecting to elevated temperature and pressure a composition comprising a cellulose ester (cellulose acetate-stearate) and a volatile solvent for a cellulose ester in such proportions that the composition does not flow at ordinary temperatures, afterwards suddenly relaxing the pressure so that rapid vaporization of the solvent takes place together with drying of the composition into a cellular mass of low specific gravity.

B.P. 575,126. Application date: 30.7.42. Accepted: 5.2.46.

Improvements relating to Plastic Compositions suitable for filling surfaces of cellular material. W. I. Taylor. To: British Celanese, Ltd.

Similar to B.P. 575,125.

B.P. 575,134. Application date: 14.10.43. Convention date (U.S.A.): 4.2.43. Accepted: 5.2.46.

Vulcanizable Polymerization Products. To: Monsanto Chemical Company.

Reveals a process of rendering vulcanisable polymers soft and tacky so that they are easier to process, and refers particularly to the treatment of synthetic polymers. It comprises treatment of synthetic rubber (Buna S.) with the condensation product of a keton (acetone) and an aliphatic amine (ethanolamine or ethylene diamine).

B.P. 575,137. Application date: 3.11.43. Convention date (U.S.A.): 26.9.42. Accepted: 5.2.46.

Improvements in Plasticized Natural or Synthetic Rubber-like Compositions. To: American Cyanamid Company.

Improvements consisting in softening and plasticizing of rubber-like compositions by admixing butyl-beta-phenoxy-propionate, butyl-beta-cyclohexyl-propionate, N-hexyl-beta-phenoxy-propionate.

B.P. 575,200. Application date: 10.2.44. Accepted: 7.2.46.

Improvements in the Moulding of Synthetic Resins and in the articles produced thereby. J. Prior. To: Lumb Hall Engineering Co., Ltd.

Moulding process for multicoloured products employing coloured premoulded designs inserted into a background of a different colour; the body of the background is afterwards moulded around the preformed inserts.

B.P. 575,260. Application date: 12.10.43. Convention date: 14.4.42. Accepted: 11.2.46.

Improvements in or relating to the Insolubilization of Hydroxylated Polymers. To: Imperial Chemical Industries, Ltd.

B.P. 575,284. Application date: 1.7.43. Accepted: 12.2.46.

Improvements in and relating to the Manufacture of Artificial Aqueous Suspensions of Rubber, Rubber Substitutes and Rubber-like Substances. N. Talalay.

Stable dispersions which mix readily with natural latices are prepared by masticating natural or synthetic rubbers until plastic in the presence of a soap, the acid radical of which is saponified by tetramethyl or tetraethyl ammonium hydroxide, triethanolamine or benzylamine.

B.P. 575,296. Application date: 26.1.44. Accepted: 12.2.46.

Improvements in or relating to the Manufacture of Artificial Threads. R. B. Richards. To: Imperial Chemical Industries, Ltd.

Elastic filaments produced from molten polythene (molecular weight 10,000-30,000) by extruding from a spinneret at a temperature between 150-320 degrees C. and subsequent chilling for solidification. The filaments are then stretched in the course of the winding operation at a controlled rate. (Rate of winding up at least three times the rate of extrusion.)

B.P. 575,323. Application date: 8.12.43 and 17.1.44. Accepted: 13.2.46.

Improvements in Injection Moulding Machines for Thermosetting Materials. R. H. Windsor and E. Gaspar.

B.P. 575,326. Application date: 15.12.43. Accepted: 13.2.46.

Improvements in or relating to the Production of Moulded or Coated Articles. R. J. Stevens and P. C. Major.

Method of producing plastic mouldings or coatings by simultaneously spraying an acid hardener and a plastic syrup from two or more nozzles into a mould or on to the article to be covered.

B.P. 575,381. Application date: 1.7.41. Accepted: 15.2.46.

Improvements in or relating to the Manufacture of Vinyl Chloride. H. M. Stanley. To: The Distillers Co., Ltd.

Manufacture of vinyl chloride by reacting acetylene and hydrogen chloride at a temperature between 120 and 150 degrees C. in the presence of a catalyst (mercuric chloride) supported on active carbon and suspended in an inert diluent (paraffin oil, di-iso-propylbenzene, pentachloroethane, etc.). Better temperature control and more economical use of the catalyst are claimed to be the improvements.

B.P. 575,386. Application date: 12.2.42. Accepted: 15.2.46.

Improvements in or relating to complex esters and polymers thereof and methods of preparing same. Pittsburgh Plate Glass Co.

Method of preparing complex esters by treating an alkyl ester of an aliphatic hydroxy carboxylic acid with an acid ester (or a salt therefrom) of a polybasic carboxylic acid and an unsaturated aliphatic monohydric alcohol.

B.P. 575,419. Application date: 1.9.43. Convention date (U.S.A.): 26.2.43. Accepted: 18.2.46.

Polyamides. To: Wingfoot Corporation.

Production of polyamides by hydrogenation of N-cyclo-hexyl-3-amino-propionitrile in the presence of nickel (as catalyst), separation of the resulting mono- and di-amines by distillation and heating these mono- or di-compounds with a polycarboxylic acid. Hydrogenation is carried out at approximately 125 degrees C. and approximately 1,500 lb./sq. in.

B.P. 575,477. Application date: 19.2.43. Accepted: 20.2.46.

Improvements in or relating to Resinous Compositions and to Fabrics or like porous Materials coated therewith. B. J. Balfe. To: Imperial Chemical Industries, Ltd.

Resinous composition comprising a polyvinyl acetal resin obtained by partial hydrolysis of polyvinyl acetate and subsequent condensation thereof with formaldehyde, and a resinous ester of a polyhydric alcohol with a saturated aliphatic polybasic acid (glyceryl adipate or diethylene glycol sebacate). Fabrics so impregnated are highly flexible and resistant to hydrocarbons.

B.P. 575,541. Application date: 9.12.43. Convention date (U.S.A.): 15.10.42. Accepted: 22.2.46.

Improvements in or relating to the Plasticizing and Softening of Rubber and Synthetic Rubber-like Materials. To American Cyanamid Co.

Process of plasticizing rubber with thiodipropionic acid esters and dibutyl thiodihydroacrylate or ditetrahydrofurfuryl thiodihydroacrylate in particular.

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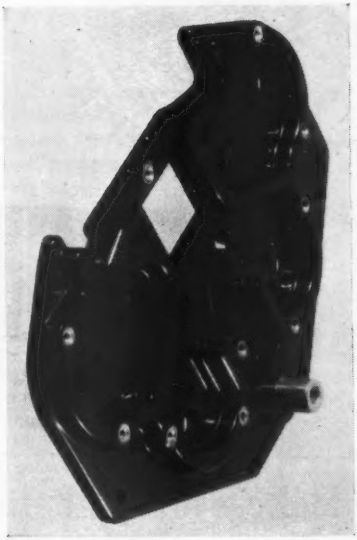

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Planned Mould Maintenance Service Aids Economical Production

Section XIX

By W. M. HALLIDAY

This present section will be devoted to further consideration of other typical mould designs and automatic insert-feeding mechanisms for delivering cylindrically shaped components into modified kinds of conventional injection moulds.

The first illustrated mechanism is one which feeds the inserts from the back of the mould, employing a reciprocating plate and push pins similar to the usual ejector gear. Also incorporated is a sliding cam plate for locking the inserts in position, this plate operating in unison with opening and closing movements of the mould blocks. By this means inadvertent endwise displacement of an insert is obviated.

Connected with this construction there is also depicted a very simple type of automatic check action to the vertical operating slide for the insert lock plate. This mechanism is capable of being readily adapted and used on most types of injection moulds using vertically acting slides for withdrawing cores, levers, pins, etc., as is usual practice.

THE necessity for maintaining insert feeding constructions of the simplest mechanical nature possible when employed on injection moulds, themselves usually of an intricate character, has been consistently urged throughout the preceding published sections on this subject of injection mould designs and associated maintenance problems. Here again at the outset of a further article no apology is made for once more inviting readers, and especially those connected with mould designing matters, to bear this important point continually in mind when developing mould constructions and attempting to evolve satisfactory insert, sorting, feeding or handling equipment.

Generally the addition of mechanism for dealing with inserts is bound to increase the complexity and number of working parts; and simplicity of construction and operation is not always easy to attain, because of number and variety of different movements or other mechanical features involved in providing fully automatic feed to a mould layout already complicated by such factors as the following:—

Multiplicity of cavities, peculiarities in their shape or location in relation to parting-line, awkwardly placed corings, undercuts or recesses, runners and air vents required, ejector pin arrangements; all these and many other factors which space here forbids detailing may combine to entail an extremely intricate final construction of the mould, which the designer and engineer may despair of successfully adapting to work with automatic insert feed.

Nevertheless, efforts to secure simple designs will repay, even though prolonged thought and attention is required to achieve them, because where they have been realized, the finished tool will give valuable benefits in the shape of enhanced smoothness of operation, quicker moulding cycle, longer trouble-free working life, reduction in frequency and seriousness of mould breakdowns, and consequently less costly maintenance service when once the mould has been placed into production use.

To secure these advantages from simple mould designs it may sometimes be necessary for the designer very drastically to modify other aspects of the design, apart from the proposed automatic insert feed. In actual fact, many instances could be given by the author to illustrate this, that only by making substantial simplifications to the whole layout of a mould was it possible and economical to employ such a type of feed.

Expressed in broad general terms, the

guiding principles of the designer should be: simplicity of construction, an essential minimum of working parts, substantial surface areas making sliding or rotational contact, avoidance of spring actions as far as practicable, ample means for applying lubricant to vital spots of mechanism, openness of the construction to permit ready access for such operations as cleaning, oiling, and making minor adjustments for taking up effects of wear or errors, the automatic insert feeding devices wherever possible to be operated by and from the normal movements of the mould blocks, or by some interlocking means to prevent mistiming.

Insert Feeding Requirements Making for Complication to Mould Design

Before proceeding with the discussion upon the first design of insert feed, it will perhaps serve a useful purpose very briefly to list a number of the more important factors which tend to necessitate a complicated injection mould design and construction, so that mould engineers being appraised of their important effects upon design layout may be led to ensure that adequate attention is paid to these points during the initial stages of the development of the mould design, and that they may be covered by the simplest form of arrangement.

The policy of roughly getting out the design of insert feed and then deferring the final layout of this until rest of mould construction has been almost completed is one which often leads to worry, added expense and unsatisfactory mechanisms.

Five of the chief factors as regards importance and frequency are here given, but this is by no means an exhaustive list, as there are a number of more minor points which may affect the degree of simplicity or otherwise possible in a mould construction.

(1) Difficult Cavity Layouts

Where a set of insert components have to be delivered and positioned during injection to awkwardly situated cavities, such as ones very deep, or recessed on their sides, or lying at difficult angles to the parting-line plane, the designer may encounter serious obstacles to the inauguration of his automatic feed.

In some instances where the above objections are present it may be necessary to feed the inserts from the rear of the mould. To do so may in turn involve splitting up the mould block into several portions fastened together instead of employing a solid piece. This may be required in order to obtain the requisite housing for the insert magazine, chute or stack, as the case may be, and the delivery mechanism, etc. Alternative routes for feeding the inserts should be considered in all cases where the cavities are situated in difficult locations, in order to determine the easiest, simplest and safest form of feed, and, what is equally important, the least complicated mechanical movements to obtain delivery.

Again, difficult corings of the mould cavity may interfere with the installation of an automatic feed, because of the inability to combine or even to install both the necessary core drawing and insert feeding mechanism within the mould block. Here again a balance will have to be struck by the designer to weigh up the advantages to be derived from the use of intricate cores, as against the loss occasioned by not having automatic feed for the inserts. In many instances more economical production will ensue by simplifying the core operating features, in order to utilize the quicker and more reliable feed.

(2) Rate of Delivery of Inserts

The rate of delivery of inserts to keep pace with the rapidity of the moulding cycle will also be another important factor likely to cause designing complications. Here once again simplicity should be an essential characteristic of any automatic feeds installed so that operation of the moulds shall be as smooth as possible. Intricate mechanical devices usually mean slower speed of operation, whilst use of a large number of working parts in the form of springs, levers, cams, slides and the like merely tend to increase the number of points at which wear, errors and eventual failure

may occur. At the same time additional maintenance attention will normally be required to keep the mechanism operating satisfactorily, in contrast to the simple type of device.

(3) Multiple Cavity Insert-feeding

In those cases where the mould has to have a large number of cavities it is preferable to design some form of automatic feed, in order to eliminate slow manual movements required for inserting parts to be moulded-in. But this factor of itself tends to involve more intricately fashioned moulds, and it may often be advisable for the designer to reach a balance by eliminating some of the mould cavities, so as to retain a reasonable degree of simplicity of construction. Where this can be done considerable saving both in initial cost of the mould and its upkeep charges may be secured. Where the insert-feeding device is not actuated by the gravity of the parts being fed, but by mechanical means, it may also be found that feeding a large number of inserts imposes too great a load upon the moulds or machine to render the working of the moulds either efficient or safe. From this standpoint, too, the designer will have to assess availability and feasibility of the layout.

Much could be said in connection with this point. Some designers incline to the view that it is better to have the maximum number of cavities in the mould even at the expense of an efficient automatic feeding arrangement; others believe that the number of cavities in the mould should be cut down to the minimum, so as to be free to go to considerable lengths to install adequately rapid feed of the inserts.

Unfortunately, no hard rule can be laid down, since each mould design is unique and must be judged on its own merits. The only sure guide that can here be given is to aim always at simplicity of construction first, and the maximum number of cavities second.

(4) Accuracy in Locating the Insert

Instances are sometimes encountered where the purchaser of the injection moulding desires a component with the location of the insert piece held within very small limits of variation. Especially will this be required in respect of the amount of projection of an insert beyond the face of the moulded article. Such needs as these will demand a most efficient and accurately constructed feeding mechanism, with possibly some additional device for ensuring close accuracy of location of the insert within the mould cavity. In the illustrated examples of automatic feeds about to be described in the present article, two simple yet very effective ways in which accurate positioning of the insert can be obtained will be given in order to indicate ways in which such requirements can be met.

Sometimes the mould designer will be presented with the request to fashion an injection moulding in which a specially shaped metallic insert is to be located in relationship to some other point on the moulding. Particular difficulties may arise in this connection should the insert component be of unusual shape instead of the ordinary cylindrical rod or rectangular strip. Requirements of this kind often tax the ingenuity of the mould designer and constructing engineer, but in all solutions the object should be simplicity so far as possible. To assist in obtaining those ends the author would commend a plan often adopted by him. It is simply this: When a mould layout has been duly completed to the designer's satisfaction, it is put on one side for a day or two, and then referred to again, each feature being checked over carefully in the light of the following questions:—"How does it function?" "Is it efficient?" "Is the function really necessary?" "Can the movement or construction be reasonably simplified?"

The above may appear elementary queries, but in practice it is surprising how often this second check over of a layout will reveal unnecessary movements and working members, improved and simplified means for achieving the same ends by means of which savings in first cost of the moulds may be effected as well as the evolution of a better con-

struction likely to give less operating troubles when placed into use.

(5) Locking the Insert

In many injection moulds it is insufficient merely to deliver an insert component to its proper place in the mould area. If it should be of large surface area, or located in such a fashion as to lie along the path of the incoming plastic stream, it will be necessary to impart some form of lock or check upon endwise movement. If this is not done it will be difficult to retain the insert in its correct place, due to the powerful thrust exerted by the plastic stream which will push the insert out of place. This further requirement will, in many cases, incur additional complications to the mould design, but to show how it may very simply be secured an example will be given later in this article. This will serve as some guide to those encountering this particular difficulty.

Again, it may be found that an insert, because of its shape, must be restrained not only from endwise movement but also from rotational tendencies when subjected to the impact of the injecting plastic material. This will again present the designer with difficulties, and maybe necessitate complications in the proposed mould construction. In ensuing pages a very economical and foolproof way in which this trouble may be solved will be explained.

This latter point is extremely important for other reasons, which are worthy of note at this stage of the discussion. Failure to provide adequate means for securing a positive stop against inadvertent endwise movement when located in the cavity, or to lock it at this point to obviate rotation, will not only result in faulty mouldings and slower rates of production, but may become the commencing causes of very serious mould breakdown. One has only to realize what takes place in the mould when the plastic material is injected therein and to appreciate the pressure behind that stream, to understand the damage which might ensue from an insert being forced back into its seating and jamming itself there. Or such a dislodged component may become trapped with some vitally important mould member, which, unable to function in its proper manner, becomes strained and may break. Then, again, an insert may be forced back and no serious harm is done at that "shot." But the delivery of further inserts to that cavity may be impeded, and if a few more "shots" are taken by an unobservant operator the minor trapping of the insert may develop into a very serious matter, entailing a great amount of repair and overhauling work from the maintenance toolmaker.

Wherever possible such checking and locking means when installed should be entirely automatic in action, rather than accomplished by separate manual movements on the part of the operator. In addition, the timing mechanism to ensure the operation and relaxation of the lock should be synchronized with the normal working of the moulds themselves.

In the illustrated examples of mould insert feeds now to be given, the author has endeavoured to select types of construction possessing the foregoing features of simplicity of construction, fewness of working parts, full automatic action, accurate positioning, and locking means for the insert as distinct from its delivery, and, above all, that kind of mechanism in every case which will give the least amount of operating trouble and have the fewest snags for the maintenance engineer.

An Interesting Push-pin Type of Automatic Feed

The illustration of the mould design and incorporated automatic feed shown at Fig. 1 gives a completely sectioned view of the assembled movable mould block only, in which member all the equipment for delivering, checking and locking the insert in place is housed. The main portions of the cavities are also situated in this half of the mould.

The mould is of the twin-cavity type for producing a pair of identically shaped domed knobs which are hollowed out for a specified depth at their largest dia-

metered end by the interposition of fixed cores members attached to the stationary mould block, illustration of which has been omitted from the drawing for the sake of clearness. Each moulding has the insert moulded-in at its smaller domed end, and the amount of projection beyond the endface had to be controlled within close limits of variation.

At this point the writer would request readers to refer back to a previous section, as published in the April issue of the journal, and to compare the designs of automatic feed illustrated on pages 211 and 213 with that illustrated herewith in Fig. 1.

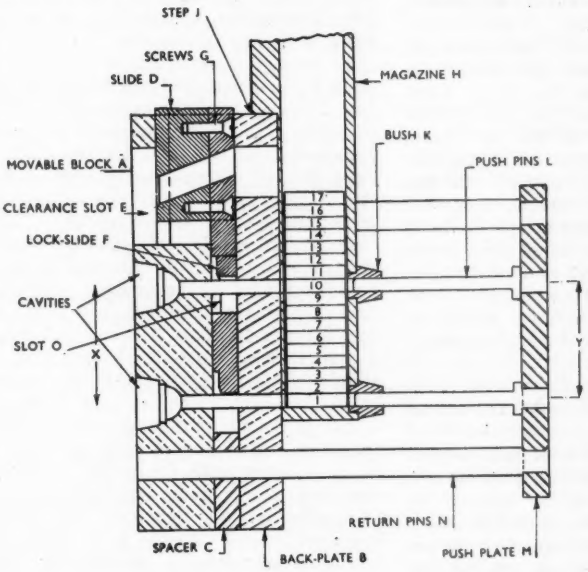


Fig. 1.

That previously published design, it should be noticed, provided for delivering insert components along a line parallel with the parting-line surface of the mould blocks. The cavities were formed in that mould with exactly half in each mould block being split across their longest dimension. Consequently, the parting-line surface of the blocks was cut out to take a slide to which push-pins and other gear was attached, whereby the insert parts could be pushed out of a suitably positioned magazine in a direction across the parting-line surface into the cavity area.

With the design now to be considered, however, a very important difference should be noted. It is, that the inserts are fed in a line at right-angles to the parting-line surface of the moulds, starting in from the rear of the movable block, being passed directly into and through the bottom of each cavity. This will be clearly understood by referring to the view in Fig. 1.

This method of feeding inserts will, doubtless, be of much interest, because numberless injection-mould designs have to be constructed in this manner in order to facilitate machining and constructional needs, and it offers a simple way of overcoming feeding requirements.

Another important point to be remarked at this stage is that this construction also embraces a foolproof checking action against endwise shift of the insert when placed into its correct position in the cavity.

This risk of inadvertent endwise movement is entirely obviated in an extremely simple manner, the mechanism for performing this function being so arranged as to operate in synchronism with the rest of the motions of the automatic feeding device. Because of this useful adaptation its application will be found especially valuable in all injection moulds where an insert must be retained within

very close limits during the entire injection cycle.

Referring now to the first view of this mould, as shown in Fig. 1, it will be observed that the movable mould block A is built up on its rear (right-hand) face to carry the requisite mechanism for comprising the automatic feed. First, a stiff-sectioned steel back plate B is secured in permanent fashion to the block by means of ordinary set screws or cap screws. Dowels should also be provided to impart correct register. This plate should, of course, be made exactly parallel.

Interposed between this back plate and the movable block are a number of small spacer pieces, as at C, these being employed in order to obtain a parallel space between plate B and the block. Needless to say, these spacers should also be ground up exactly parallel and the same thickness. The number of spacers required in the present example is three, one long one running along the bottom edge of block, and two shorter ones for the top edge. This is necessary so as to leave an adequate gap into which the magazine member may be introduced, as will be explained later.

The upper portion of the block A is gapped out on its rear face for a certain depth, an indicated, to receive a short slide D. This parallel slide piece should be made a free sliding fit within the gap so formed, and preferably tenoned or dovetailed, in order to prevent the slide from lifting out of position. This slide is actuated by means of an angular pin affixed to the stationary block, and projecting at the appropriate inclination and distance, so as to give slide D the required length of travel. An elongated clearance slot is machined through the movable block from the parting-line surface, as shown at E, through which the angular pin is free to pass in all positions of the movable block. It will also be observed that the extreme right-hand side of this slide is exactly in line with the rear face of the block.

Attached to the right-hand side of slide D is another narrow lock slide F, which is held in place by means of countersunk head screws G and dowels. At its lower end this slide is a free fit within the gap formed between back plate B and the block. The inclined hole in slide D is continued through lock slide F after this latter has been finally positioned and fixed in relation to slide D.

At the bottom of each cavity impression in the movable block a parallel hole is machined clean through to the back of block. This hole is made large enough to take the insert components. The centre distance X of the cavities must be carefully formed for a reason to be made plain later in this description.

To the right-hand end face of the back plate B is affixed the detachable magazine tube H. This magazine is located for correct height by means of the step J formed on its left-hand side and resting upon the top edge of the back plate, as shown. Alignment laterally is controlled by a keyway and key engagement, not here illustrated. By this means a spent magazine is very easily removed simply by lifting clear of the keyway, whilst a loaded tube is quickly placed in position by sliding it along its keyway until step J bears on back plate. By having such a simple method of attaching magazines much time is saved during production.

The left- and right-hand walls of this magazine are drilled in such a manner as to coincide with the holes in block and back plate running from the bottom of cavities. On the right-hand wall these holes are bushed up as at K, in order to impart longer bearing surface for the push-pins L employed for pressing insert components from the magazine chamber into their seatings in mould block

The chamber of the magazine is made slightly larger than the insert parts being handled, so that these members are capable of falling freely with their own weight, yet not having too much clearance to allow them to take up an oblique position within chamber.

Push-pins L are made sufficiently long to allow them to travel within the back plate and block the required distance whereby an insert is pushed into the

cavity area the proper amount. It will be seen that these pins are shouldered at their other end and press fitted into holes in the push-plate M. The centre distance Y of these pins must be made exactly the same as centre distance X of the cavities, whilst this distance must also be made an exact multiple of the diameter of the insert component.

The push-plate M is guided and held in correct relationship to the block by the stiff return pins N, cylindrical in shape, to which it is permanently secured as shown. These pins slide freely within holes provided in the movable block and back plate, and are made of such a length as to cause the insert push pins to pass out of the magazine chamber on its right-hand side when the mould blocks are in the closed position. This movement of the return pins is operated by the closing of the blocks themselves. Immediately the movable block approaches the stationary block the projecting ends of the return pins will contact the parting-line surface of the fixed block first; continued closing movement of the other block will serve to depress these pins within the latter block, until their ends come in line with its parting-line face, this also coinciding with complete closure of both blocks.

It should also be noted that the lower end of magazine H is blanked off in such a way as to bring the first insert component, number one, exactly on the same horizontal centre line as the cavity centre. Because of the spacing of these cavities the next insert coming in line with the upper cavity is the one numbered 10 as shown.

The lock slide F, at its lower end situated between backplate and block, is specially shaped in the following way to enable inserts to be fed without interference and to secure a positive check action.

For the upper mould cavity and the inserts passing from magazine thereto, an enlongated slot 0 is cut clean through the slide as indicated, and the slide is also thinned down a small amount on its left-hand side immediately surrounding the slot. At the extreme lower end the slide is similarly thinned down, whilst the extreme tip portion is bevelled off to impart easier lead action when the slide makes engagement with an insert. This bevel also serves another purpose, which is to be explained later when we come to the part describing the method of functioning of the device.

The illustration in Fig. 1 shows the push pins and push plate, etc., drawn backwards in their open position, block A not yet having completed its opening movement. The push pins, etc., are thus in readiness for making a feeding stroke to fill up the two cavities with inserts accomplished in the following manner.

Sequence of Movements of Mould and Automatic Feed

The method of operation of this feeding device is equally simple, as will be gathered from the following brief description. After a moulding shot has been performed, the movable block is withdrawn and the finished moulded article ejected out of the cavity in the block during the early portion of its opening stroke. After this has been accomplished, the movable block continues to move away from the stationary block (with all the feeding mechanism just described occupying the positions indicated in Fig. 1) until the right-hand side of the push plate M bears against a fixed stop bracket or plate (not here shown), which latter may either be attached to the bed or the platen guide bars as is convenient. Immediately the movement of the push plate is arrested in this manner, further opening movement of the block will cause the plate and push pins to move inwards and the push pins will therefore pass through the magazine chamber carrying before them inserts 1 and 10 respectively, these latter being pushed to their correct endwise position within the cavities when the push plate has reached the limit of its travel.

On the return stroke of the movable block, that is, when it undergoes the closing movement, the push plate and attached pins remain in the closed posi-

tion until the left-hand end of the two return pins M, now, it will be noticed, projecting well over the parting-line face of the block A, contact the parting-line face of the fixed block, whereupon the push plate will again be forced outwards so as to bring the pins clear of the magazine chamber, as shown at Fig. 1. The stack of inserts will then be free to fall so as to bring a fresh pair exactly opposite the seating holes in the block in readiness for the next feeding stroke.

At a certain point in the return stroke of the push-plate mechanism, the push pins will have been retracted a sufficient distance to afford clearance for the lock slide F, which is then timed to commence its downward stroke between backplate and block by the engagement of the angular operating pin with slide D. This causes the lock slide to move vertically until the ends of the insert components are sealed off at their right end, as is clearly shown in the illustration at Fig. 2.

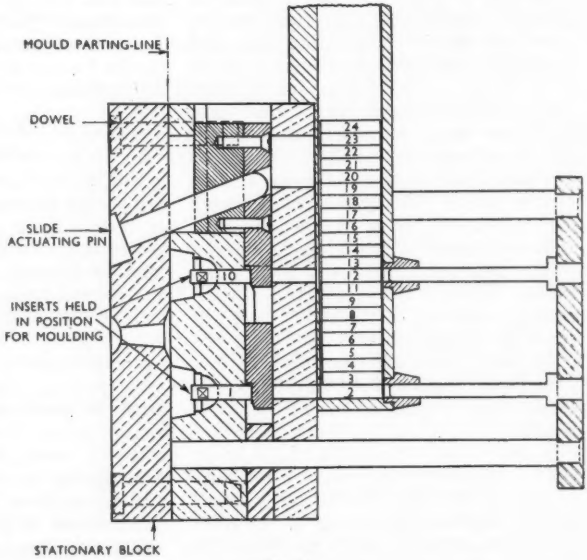


Fig. 2. .

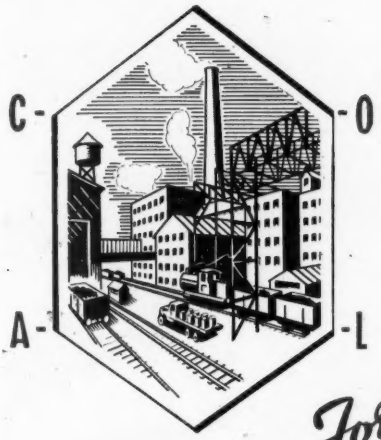
This view shows the positions occupied by the various mould and automatic feeding members when the mould blocks have been closed in readiness for an injection shot. Referring carefully to this drawing, it will be noted that the lock slide has now passed down the space between backplate and block to bear against the ends of the inserts, in which manner it will be impossible for the latter to be pushed backwards out of place when the plastic material is injected into the cavities.

When this stage of the cycle has been reached, the return pins will have forced back the push plate and its attached push pins to their original extreme right-hand position, thereby again permitting the column of insert components within the magazine chamber to fall down so that parts 2 and 12 are brought in line with the cavities. Thus everything is in readiness for the next opening movement of the mould block to obtain delivery of these two inserts into their respective cavity seatings in the manner just described.

The reason for the bevel on the end of the lock slide is to ensure that once the slide is in operation, no damage may be caused to it or the inserts due to any slight difference in endwise positioning of the insert by the push pins. Obviously, if the pins failed to force the inserts far enough along their seatings, the descending lock slide would run the risk of trapping itself on the body of insert.

By forming a slightly inclined lead portion on the slide as shown, small deviations in position of inserts are easily overcome.

As will doubtless be appreciated, this



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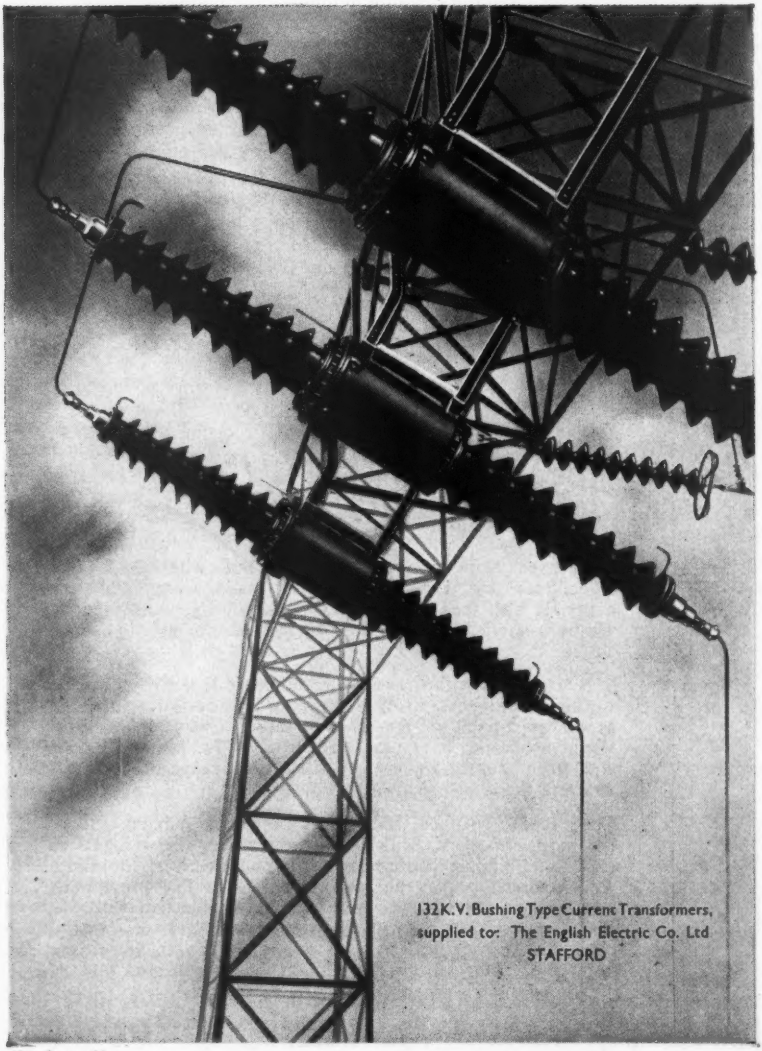

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mechanism is capable of being operated at high speeds, especially if a number of identically shaped magazines are employed, with one loaded one being used on the machine whilst the others are being cleaned and reloaded at a separate station by a girl operator. In this manner almost continuous production may be maintained.

Advantages of this Construction

Now having carefully described the design, construction, and method of operating this simple form of automatic feed, it remains to mention briefly the various advantages and disadvantages of the mould, viewed particularly from the special angle of the maintenance toolmaker who will be charged with servicing the mould during production, consideration of which is, of course, the chief purpose of this series of articles.

A number of useful features are worthy of note as follows:—

(1) The locking action on the insert to prevent unwise endwise movement can easily be arranged in such a manner as to deal with a large number of components simultaneously instead of for only two inserts, as shown in the drawings. If the inserts are located on the same vertical or horizontal centre lines this will only necessitate a longer lock slide having additional slots and locking steps.

(2) By a very simple modification the locking device can be adapted so as to impart not only a positive stop against endwise movement, but also to prevent rotation of the insert. To accomplish this, all that would be necessary would be to attach leaf springs to one side of the slot through which the insert has to pass, so that this spring would exert a specified pressure upon the side of component, when the slide was moved to lock position. Other similar ways will suggest themselves for securing the same end.

(3) The locking and check action will be in no wise impaired if the operating lock slide is arranged out of the vertical plane. In point of fact, this slide may move vertically, horizontally, or at any convenient intermediate inclination to suit the requirements of mould construction. This imparts a very useful degree of flexibility to the designer.

(4) The construction when given the additional improvements to be explained later, whereby wear can be more easily avoided, or corrected, and to facilitate adjustments, etc., is practically foolproof in action, and once an operator has been correctly instructed in the proper use of the mould, little trouble need arise.

(5) It is fully automatic and the timing of the various motions of separate members cannot be upset, short of the complete failure of some vital working member.

(6) Since the number of working parts is very small, the mechanism is extremely simple and smooth in operation.

(7) The construction adds very little extra cost to the injection moulds, and is of such a simple mechanical nature as to permit ready adaptation being made to existing moulds not originally designed for such a type of feed.

(8) Such operations as cleaning, adjusting, oiling, etc., are greatly facilitated by reason of the easy access afforded to the main elements of the construction.

Disadvantages of the Construction

It is only appropriate that some mention should be made of the several disadvantageous features inherent in this construction, but it is emphasized that these almost exclusively refer to deficiencies in construction rather than to faults of design, and since these former usually constitute 75 per cent. of the maintenance engineer's troubles, it will be well worth while to consider at some length the several drawbacks possessed by the device.

(a) One of the chief disadvantages to be noted is the lack of positive lock on the positioning of the slide D to which the lock slide is secured. This will almost certainly quickly prove a serious snag against successful operation. It will be seen that the actuating pin set in

the fixed block becomes completely disengaged from this slide D in movable block, hence the latter when in its raised position will tend to fall by its own weight once the fit within the guideways become easy. Should this occur, of course the possibility of a serious trapping of the push pins, or the inserts with the lock slide, becomes possible. Or, if the mould be accidentally closed before the operator notices such an occurrence, very extensive damage both to lock slide, push pins and insert members may be done.

A very useful and inexpensive way in which this danger may be entirely eliminated will be explained and illustrated later. The special advantage of this device is that it is entirely automatic in operation and is so arranged to function from the normal lift of the lock slide itself, thus requiring no external separate manual motions or attentions.

Manual methods for securing positive lock on such slides are never really advisable or successful because of the inability to ensure 100 per cent. efficient observation on the part of an operator, and the risks of damage from even one slip are liable to prove so costly in effecting repairs, etc., that such methods become inadvisable.

All such interlocking means must, as far as possible, be fashioned fully automatic and preferably integral with the other mould mechanism, entailing no additional or separate movements.

(b) Another important drawback is the absence of any means for regulating the travel of the push plate and push pins. In a construction of this type it will be highly desirable to have some simple means for adjusting the amount of stroke of the push pins, so that the extent of insert projection into the mould cavity can be controlled and adjusted if required.

Referring to Figs. 1 and 2, it will be observed that the stop to the push plate simply comprises the ends of the bushings K situated in wall of the magazine, and consequently no adjustment is possible.

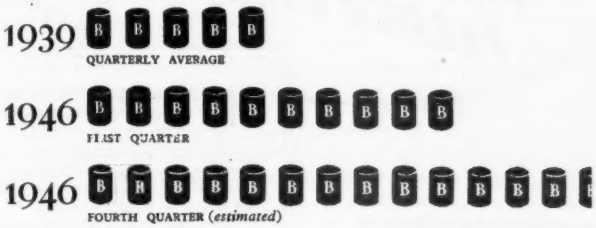
To provide for this it will be necessary to drill and tap the push plate to receive a number of stop screws, which can be threaded clean through the plate and locked by means of small lock-nuts in any given position. The ends of these stop screws would then make contact with back plate B when the push plate had made the requisite amount of travel.

(c) In respect of guiding the push pins, it will be found advisable to install hardened steel renewable liners in the movable block seatings running from bottom of cavities, in the adjoining holes in back plate. In the present construction two bushings K only are used. Unless some such means is applied the danger of rapid wear of the surface of holes will be great. Should this develop, other more serious troubles would speedily accrue, as, for instance, the following: Undue wear would lead to slackness of the pin within the hole, thereby resulting in the formation of flash at base of domed part of the finished moulding. Flash formation here would also tend to cause sticking of the push pins, as fine slivers of plastic material would find access within the worn portions of hole and along sides of insert and push pins. Tightness of working would then produce additional strain upon the push pins and connected operating mechanism, with liability of distortion or even fracture of the pins.

Another even more serious danger arising from slack-fitting push pins is that of misalignment of the pins with the insert components within the magazine chamber. Instead of contacting correctly on the end of only one insert, worn pins or their seating holes would allow the pin end to take up a wrong position and overlap a slight amount the adjoining insert, which, of course, would tend to be displaced and, perhaps, trapped when the push pins were operated to feed components. Another useful step still further to guard against this latter occcurrence would be to make the diameter of the push pins somewhat smaller than the outside diameter of the inserts. There will be limitations to such action, however, since in many instances the diameter of the insert itself is so small that any reduc-

BEETLE—THE FACTS

As is the case with most good things in this first year of peace, the supply of Beetle mouldstuffs is not equal to the demand. Since VJ-day output has increased to a record figure, but six years pent-up desire for consumer goods in bright colours makes the demand even larger. Here is B.I.P.'s output, shown in pictorial form:—



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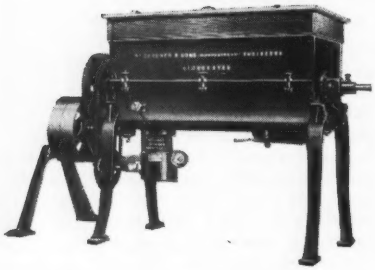

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tion would result in a push pin of too slender proportions to withstand the work devolving upon it.

(e) The method of utilizing a number of spacer blocks between the movable block and the back plate, whilst inexpensive and convenient from a manufacturing point of view, is not an entirely reliable form of fixing, and in the case of mould required for large-scale production runs would prove a source of trouble. Unless very considerable care were taken in assembling such spacers and fastening them securely, troubles might arise due to their loosening, as a result of clamping bolts being jarred loose with vibration. Should this occur, other snags would surely follow, such as distortion of dowels, push pins and return pins, since all these members have to pass through back plate and movable block, and in some locations the spacers themselves. The lock slide also would be affected if any slackening of the fit between spacers and back plate occurred.

The most reliable way would be to machine the movable block or back plate, as the case may be, with a suitable slot to take the lock slide, then obviating the need for spacer pieces altogether. If such constructions are to operate successfully and with a minimum of trouble there should be ample rigidity and stiffness in the securing together of the main members such as these.

(f) It will also be found of great assistance to the mould engineer if some means for adjusting the height of the floor of magazine chamber were provided. Especially will this be advisable where a mould is operated with a number of separate magazine members, as slight variations in their vertical settings will be prone to arise. Such an adjustment could comprise a flat plate small enough to pass within the magazine chamber freely, this being passed to the floor of same, and the latter portion being drilled and tapped to take two or more adjusting screws, which would raise or lower the inserted plate as desired, so altering the vertical position of the stack of inserts.

(g) In many mould constructions it may prove difficult to machine a keyway or slot on the right-hand side of the back plate for housing the magazine, or the presence of such an extensive keyway may result in too drastic a weakening of the back plate itself as to render it incapable of resisting distortion. This could be overcome by using a different method of attachment. Stiff pillars could be affixed to the top edge of the back plate, and an extension plate secured to the magazine, through which suitable holes could be drilled to pass over the pillars. Thus the task of fitting or removing a magazine would simply consist of lifting it over or off these pillars. If the latter were made sufficiently large in diameter a very rigid means of fixture would be obtained at little expense, and it would, moreover, be almost foolproof.

There is one other important point worthy of attention in connection with use of detachable magazines. Care will have to be taken that dirt, excess plastic material, etc., are not allowed to collect in the bottom of the magazine chamber, as this would affect the vertical alignments of the inserts contained within magazine. Similarly, at the points where the magazine fitted to the back plate complete cleanliness would have to be ensured, otherwise the whole magazine could be misaligned with back plate, and this would entail stiffened working of the push pins, and additional wear on these parts.

Maintenance Services Connected with this Construction

As will be appreciated from the numerous examples of mould constructions previously published in this series which have indicated the preferred forms of mould layout and manufacture so as the better to aid the work of the maintenance toolmaker, there are a number of important points connected with the mould design under consideration which deserve careful attention and in some cases correction according to the principles already illustrated. They are:—

Push pin anchorage. These members should be secured to the push plate by

means of an ample shoulder at the left-hand side of plate and a threaded shank passing through the plate with a lock nut screwed on to shank at right-hand side, so preventing any movement of pin in either direction. Adjustment of the pin is easily effected by inserting a thin shim washer between shoulder and face of plate, or by removing a slight amount of stock from the right-hand face of shoulder. These pins, as already explained, should slide in hardened bushings capable of easy renewal when wear takes place.

Guide pins for push plate. Separate stationary guide pillars would be a great advantage for controlling the push plate instead of the return pins employed in existing construction. The push plate in this case would then be provided with hardened bushings in which the guide pillars would move.

Return pins. The return pins riveted to the push plate will also prove a source of adjustment trouble. An improved method of construction would be to employ a pin fastened to the push plate by a threaded shank into a tapped hole, and a lock nut situated each side of plate. It will often be required to alter slightly the setting of these return pins, which will be rendered somewhat difficult by the method of fixture by rivet, whereas two lock nuts can easily be released and the pins adjusted as desired.

Push Pin Guide Bushings in Magazine Wall

Bushes K should preferably be entirely discarded and in their place a stiff-sectioned steel plate secured either to the magazine itself, if this member is of sufficiently large proportions at this point, or, better still, a stepped plate which could then be permanently secured to the back of the plate B, the stepped portion being made to allow clearance to the magazine. This procedure would ensure far more likelihood of maintaining the correct alignments and preclude excessive wear of push pins.

Lock Slide Alignments

Where moulds are to be employed for long production runs, such prolonged operation would require the provision of wear adjusting means for the lock slide F and the operation slide D also, which would be subjected to same wearing effects. This could take the form of the usual tapered gib in soft wear-resisting material such as phosphor-bronze fitted in such a manner as to afford ready adjustment as wear of slide occurs.

Interlock for Slide D

It has already been mentioned that one of the great disadvantages of this construction is the lack of positive stop against movement of slide D when this member becomes disengaged from the actuating pin in fixed block. In Fig. 3 is shown an exceedingly interesting and useful modification to the existing slide design whereby this member is automatically restrained from falling by its

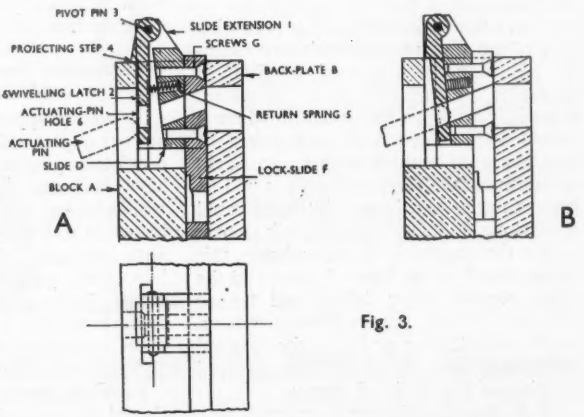

Fig. 3.

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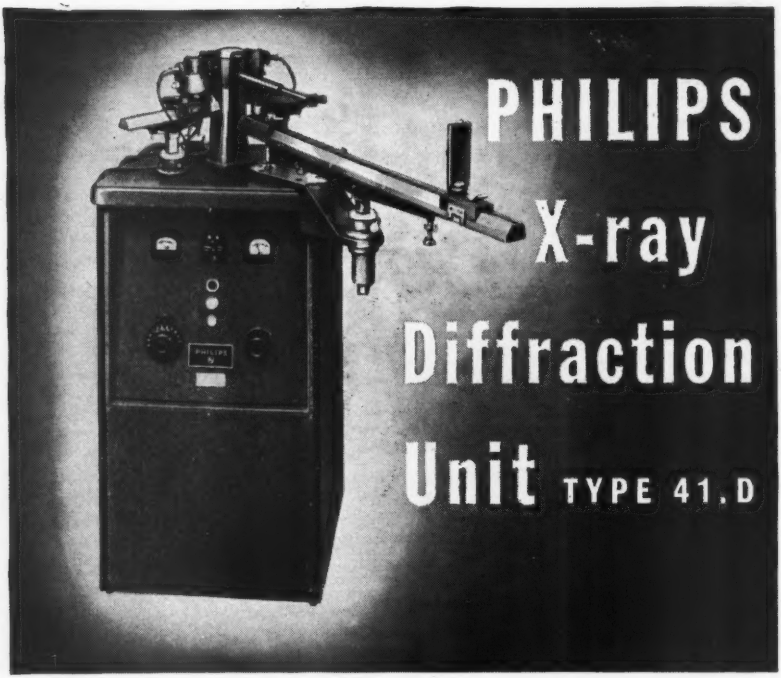

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own weight or the vibration of the machine after the actuating pin has been completely withdrawn from the angular hole through slide.

This is a method very often employed by the author with complete success, and it is here recommended on account of its simplicity, inexpensiveness, ready adaptation to existing slide constructions, and fool-proof action. It will also be applicable with the same measure of success to check the undesirable accidental shifting of core slides, ejector pin slides, and the like, which are located along vertical planes or have to move along steeply inclined paths.

The view A in Fig. 3 shows a partial sectioned cut of the same movable mould block assembly to indicate the modified vertically acting slide for the lock slide. This arrangement is very simple and comprises, first, an extension to the top of the slide D, as shown at 1. This extension is cross slotted to receive the swivelling latch member 2 which is pivoted to swing freely on pin 3 which passes through a cross drilled hole in the extension on top of slide.

The front (left-hand side) of slide body is machined with a step as shown, the bottom face of which lies at a sufficient angle to permit the latch member adequate movement, and at the same time to allow the latter to bear down for full length of its face when in the operating position, shown in the view at B, to which reference will be made shortly.

The upper left-hand side face of the latch is provided with an integral stepped part, as shown at 4, which is so situated and arranged as to pass over the top edge of block A when the slide has been raised to its topmost position. For safety reasons, a slight clearance of 1/32 in. should be given to this step to ensure that the stop operates, even though the slide should make a slightly shorter stroke due to additional strain imposed by lack of lubricant, tightness of actuating pin, etc.

The hole for inclined actuating pin in the fixed block is drilled clean through the latch and through the body of slide D in usual fashion with the latch drawn back to position shown at B. A small compression spring 5 is housed in a blind hole in the slide D at one end and bears against the back of latch 2 at its other end, whereby the latter is maintained in the position illustrated at A when the actuating pin has been withdrawn from slide and latch.

As will be seen, this allows the spring to force the latch outwards away from slide D and brings the step part above and overlapping the top of movable block, thereby arresting any tendency to move downwards of the slide. It will also be noted that the actuating pin hole through the latch member has become somewhat misaligned with the main hole in slide D, due to swivel action of former part, but when the blocks are closed and the actuating pin (here shown in heavy broken line) contacts the latch it will first have to depress this member back against the pressure of spring until the latch is bearing down against slide, whereupon the pin will be free to pass through both members, and at the same time the stepped projection 4 will have been drawn completely clear from top edge of block, thus allowing the complete slide assembly to move vertically along its guideways.

The view at B shows the position of the various units in the useful construction when the inclined actuating pin has closed the swivelling latch inwards and is in mesh with both that member and the main slide D.

From the maintenance engineer's point of view, this will prove a valuable improvement to the construction since very little can go wrong with its functioning. The stepped latch should be made from hardened steel, as also the pivot pin, in order that wear and errors may be kept at a minimum. Provided that a sufficient amount of clearance is given between the step numbered 4 and the top edge of the mould block when the slide is at its highest position, there will be no danger of its failing to engage.

Care will have to be observed to ensure that the swivelling latch is maintained in a perfectly free condition to prevent stick-

ing or stiff action, which would prevent the spring from opening the latch. Dirt should also be kept out of the space between latch and main slide and the pivot-pin fulcrum bearing. Provision should be made for lubricating the various sliding and swivelling points.

This form of positive automatic stop will function equally well at other than vertical positions, and can safely be adopted for use on slides moving along inclined tracks or even horizontal ones.

In cases where it is necessary to prevent the slide not only from falling down by its own weight, but also from being vibrated further outwards, the above positive stop device can easily be adapted to achieve both purposes in the following manner.

Instead of the stepped side of the swinging latch being arranged to rest upon the top edge of the mould block, a slotted plate should be affixed to this latter member, in a permanent fashion, and the step projection 4 made to pass into the slot provided in the fixed plate. This would prevent movement of the slide in any direction until the swivelling latch member had been closed inwards by the action of the actuating pin in the fixed block.

Conclusion

Summing-up, the maintenance needs of this type of design and construction of automatic feed will be exceedingly light.

In the next article in continuation of this section, the author will deal with two modifications or variations of this present design, wherein the magazine type of feed is not used. In its place a continuously operating barrel type of feed is employed. The methods of obtaining the necessary motions should prove interesting.

MICROSCOPIC EXAMINATION

(Continued from page 239)

and that between the time taken to reach stability and the percentage humidity (Curve B), on the other, from which it will be seen that below a relative humidity of 50 per cent. the time taken to reach a stable point falls off considerably.

From the foregoing remarks one may conclude that in order to overcome the objection to using hot, dry woodflour, the better procedure would be to condition it at 55 per cent. relative humidity and carry out the mixing in an atmosphere whose humidity and temperature are controlled to the figures mentioned.

The aforementioned figures are all, presumably, relating to woodflour processed from softwood and of the standard 80 mesh. It is quite conceivable that the re-absorption values will be different for different meshes of softwood flour, and will also vary with the lignin content, so that the more highly lignified hardwoods could be expected to behave differently. However, as there does not appear to be any data available, one can only assume the existence of this condition.

At this stage the author would like to express his appreciation of the help received from Mr. W. S. Dahl, who kindly supplied the samples of woodflour from which the photomicrographs were taken.

South American Markets

The plastics needs of Latin America have been summarized by the United States Department of Commerce, which says that Central and South America can absorb a total of about 10,000,000 pounds of plastics annually in the next two or three years, including textiles, luggage, novelties, tubing, and offer a big field for plastic-bonded plywood for prefabricated houses.

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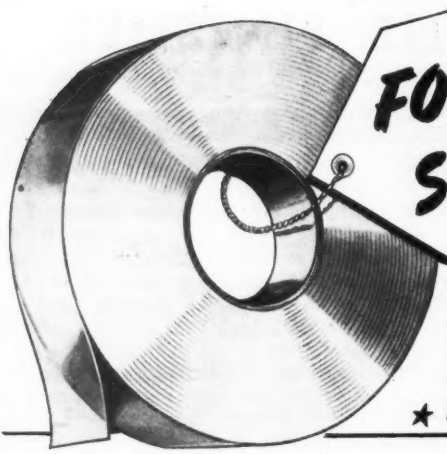

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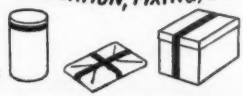

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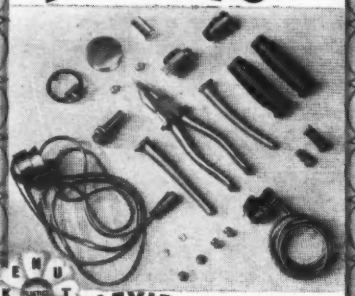

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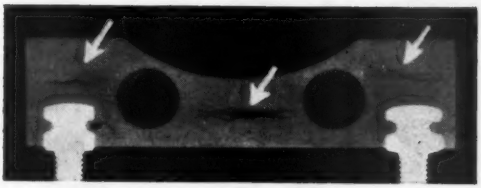

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Radiograph of a moulded Bakelite block with metal inserts: the arrows indicate porous regions, due to improper curing of the plastic.

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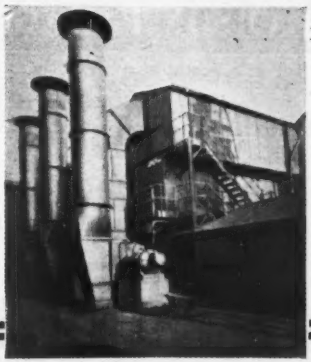

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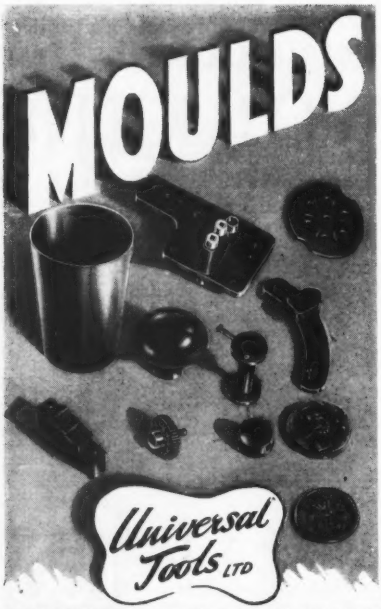

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Technical expert required, thorough knowledge of modern plastic materials to initiate tool design for use in production of plastic articles. Box 38, care of "Plastics." 108-6167

Manager, storekeeper and order clerk wanted for plastic and photographic material business. Lloyd's, 72 Bridge Street, Christchurch. zzz-49

Toolmakers and skilled craftsmen required for factory, Romford, Essex. Exceptional ability required for which adequate remuneration will be made. If you are confident of your ability write, giving full details, to Box 1622, care of "Plastics." 108-6370

Two Draughtsmen required for tool design office. Experience of mould design an advantage, but not essential. A.E.S.D. rates. Write, stating age, and particulars of experience, to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea. 109-6340

Foreman required for small factory in the North of England. Mechanical knowledge essential, practical experience with plastics desirable. Write, stating age, salary required, and experience to Box 2038, care of "Plastics." 108-16

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Chief Draughtsman with experience of tool design in connection with compression and injection moulding, also with full general light engineering training. Age preferred 25-35. Write fully all details of experience and state salary required. Harrow district. Box 2037, care of "Plastics." 108-15

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Manufacturer of injection and compression moulded products require representatives to the wholesale and shipping in the following territories:—London, Birmingham, Yorkshire, Northumberland, Glasgow, Norwich, Bristol and Wales. Only first-class need apply. Box 2040, care of "Plastics." 108-18

Technical Male Clerk required by plastics company, N.E. London area. Some chemical knowledge desirable. Should be capable of typing own correspondence. Age not over 35. Write, giving full details of qualifications, previous experience and salary required, to Box 2041, care of "Plastics." 108-19

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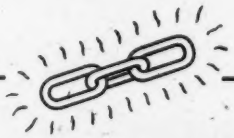

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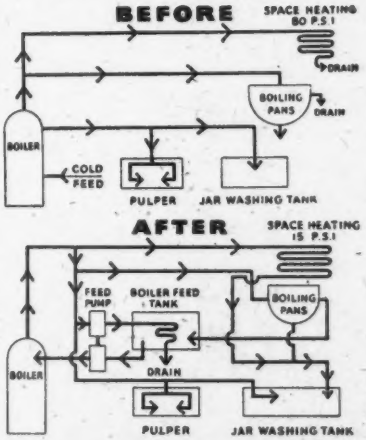

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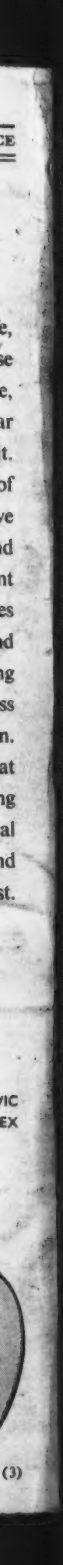
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